UNIT 1: STATISTICS

GRAPHICAL REPRESENTATIONS

Graphical Representations Lessons and Exercises

Lesson	Assignment	Date
1. Intro to Graphs and Types of data (pg.4-5)		
2. Bar Graphs (pgs. 6-13)		
3. Histograms (pgs. 14-18, 22)		
4. Frequency Tables (pgs. 19-21)		
5. Line Graphs (pgs. 23-27,30)		
6. Interpolation and Extrapolation (pgs. 28-29)		
7. Circle Graphs (pgs. 25-27)		
8. Comparing Types of Graphs (pg. 31-35)		
9. Interpreting graphs and Misleading Data (pgs. 41-45)		

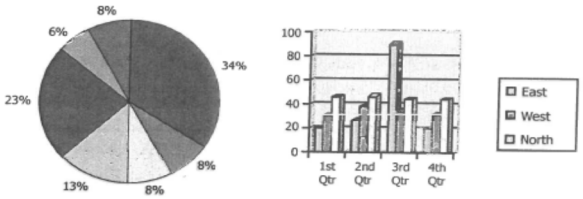
Introduction:

This unit focuses on displaying and interpreting data using various graphs. It also focuses on how to select the most suitable type of graph to present different types of data. Finally, this module shows how graphs are used to emphasize a certain point of view.

Sometimes a picture is easier to understand than a paragraph. Similarly, sometimes a graph is easier to understand than a list of numbers. The type of graph drawn usually depends on the kind of data one wants to illustrate.

The ***4 types of graphs*** that will be studied this unit are:

1. Bar Graphs
2. Histograms
3. Line Graphs
4. Circle Graphs



Choosing a scale and interval for bar, histogram, and line graphs (graphs with axes)

- For bar, histogram & line graphs, choose the scale of the axes carefully. Choose an appropriate scale so that all the numbers in the range will fit (it must ***include all the values in the range)***.
- The scale should be reasonable so that your graph is ***as large as possible*** for the space given and for your data.
- The interval must be uniform so that ***each box on the axis must represent the same number across the whole axis*** (ie label evenly, counting by 1, by 2, by 10, by 1000... for the entire axis – *don't change partway up the axis*). The two axes can have different scales from each other but the scale on one axis doesn't change. Also try to use interval that will make it the ***easiest to graph the kind of numbers*** **in the data**

How to determine Intervals

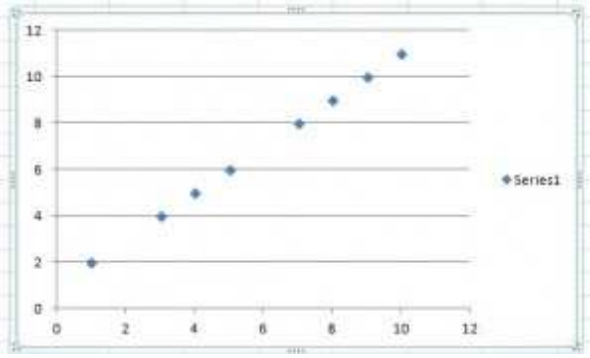
Favorite Singer	Number of Teachers
Toby Keith	22
Madonna	15
Elvis	11
Sting	5
Sinatra	2

- The interval is decided by your scale.
- In this case your scale would be from 2 – 22 and you want the scale to fit the graph.
- The best interval would be to go by 5's.

Lesson #1: Types of Data

Graphs represent either ***discrete*** or ***continuous*** data:

1. ***Discrete data*** is something you can count the ***whole number*** of.



The units of measurement, such as # of CDs, cannot be split up; there is nothing between 1 CD and 2 CDs, nor can you purchase 2.5 CDs. There are ***no decimals*** or ***fractions*** that exist between the whole numbers. They are ***distinct*** and ***specific*** values, so the graph will only have ***points*** representing the data. We do ***not*** connect the points with a line.

2. ***Continuous data*** is something you can ***measure***, such as time, temperature, distance, and weight.

The scale of measurement, such as distance, has meaning at ***all points*** between the numbers given. For example, we can travel a distance of 1.2 or even 1.63 kilometers. There ***are decimals*** or ***fractions*** between the whole numbers, so the points are ***connected*** with a ***line*** representing the relationship between the variables.

Example: Place a *'D'* for ***'discrete'*** or *'C'* for ***'continuous'*** next to the types of data:

a) _____ someone's height in centimetres

b) _____ number of languages someone speaks

c) _____ temperature range in a day

d) _____ speed of a train between cities

e) _____ number of cars in the parking lot, sorted by color

f) _____ favorite subject in school

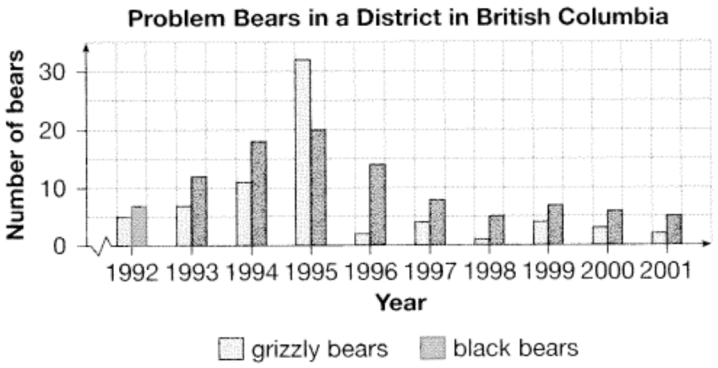
Lesson #2: Bar Graphs

In this lesson, you will:

- Study bar graphs and the type of data they represent
- Create bar graphs from data
- Explore the advantages and disadvantages of using bar graphs to represent data

The Parts of a Bar Graph:

Amy is a conservation officer. She educates people about "problem bears." These are bears close to food in populated areas. What information can Amy get from this graph?



❶ Describe the data in this double-bar graph.

The categories on the horizontal axis are _____.

The two groups of data are _____ and _____.

trend
a relationship between two variables

❷ Describe the **trend**. As the years increased, the number of problem black bears _____ until 1995. Then it _____, except for _____.

range
the difference between the greatest and least number in a set of data

❸ What is the **range** for each of these?

problem black bears: 20 − _____ = _____

problem grizzly bears: _____ − 1 = _____

❹ Circle the correct word.

- The greater range means that the number of problem grizzly bears changed **more / less** than that of black bears.

Bar graphs use vertical or horizontal bars to display ***discrete data*** sorted into ***well-defined categories*** that are clearly ***separate*** from one another.

A bar graph is used for ***comparing quantities*** of ***many items***. It is suitable for displaying data because each bar ***represents a quantity***.

All bar graphs have both a ***vertical axis*** and a ***horizontal axis***.

The above graph is a vertical bar graph because the bars are drawn *vertically.* The ***vertical or y-axis*** is the ***quantitative axis*** describing the ***amount***. It is usually labelled, 'Number of…', because it refers to the *number of items.* The ***horizontal or x-axis*** is the ***qualitative axis***, divided into ***categories***.

NOTE: On a horizontal bar graph, the bars are drawn horizontally. In this case, the ***horizontal axis*** would be the ***quantitative axis***, and the ***vertical axis*** would be the ***qualitative axis***.

Drawing Bar Graphs:

Bar graphs must have the following:

- A title for the graph
- A title and ***labels*** for the qualitative axis
- A title and ***scale*** for the quantitative axis
- ***Accurately*** drawn bars with a space
- A ***legend*** (***only*** if you are drawing a double bar graph)

To draw a good bar graph, you need to follow 5 steps: (*see also TAILS p. 9*)

1. Be sure the data is ***discrete*** and ***sorted into categories***.

   Question: What is your favorite subject?

   Phys Ed: 179 students *Math: 14 students* *Art: 28 students*
   French: 51 students *Music: 106 students* *English: 65 students*
   Science: 47 students

2. ***Label*** the ***axes***. Determine the qualitative and quantitative axes and label them.

3. Determine the ***maximum value*** of the sorted data. By knowing the ***highest value*** of any category, you know how long the longest bar will be. The ***quantitative axis*** should always start at zero, and should extend slightly past the maximum value.

   Highest value is phys ed: 179 students

4. To choose the scale, determine the ***interval*** of the ***quantitative axis***. You need to label a ***reasonable*** number of equal increments (not too few or too many – and should fill up space as much as possible). The scale should be **appropriate** (to most easily locate the top of the bars) and uniform (skip the same amount for each increment). (see p. 4 for more info)

   The maximum value is close to 180. Increments of 10 or 20 would be reasonable.

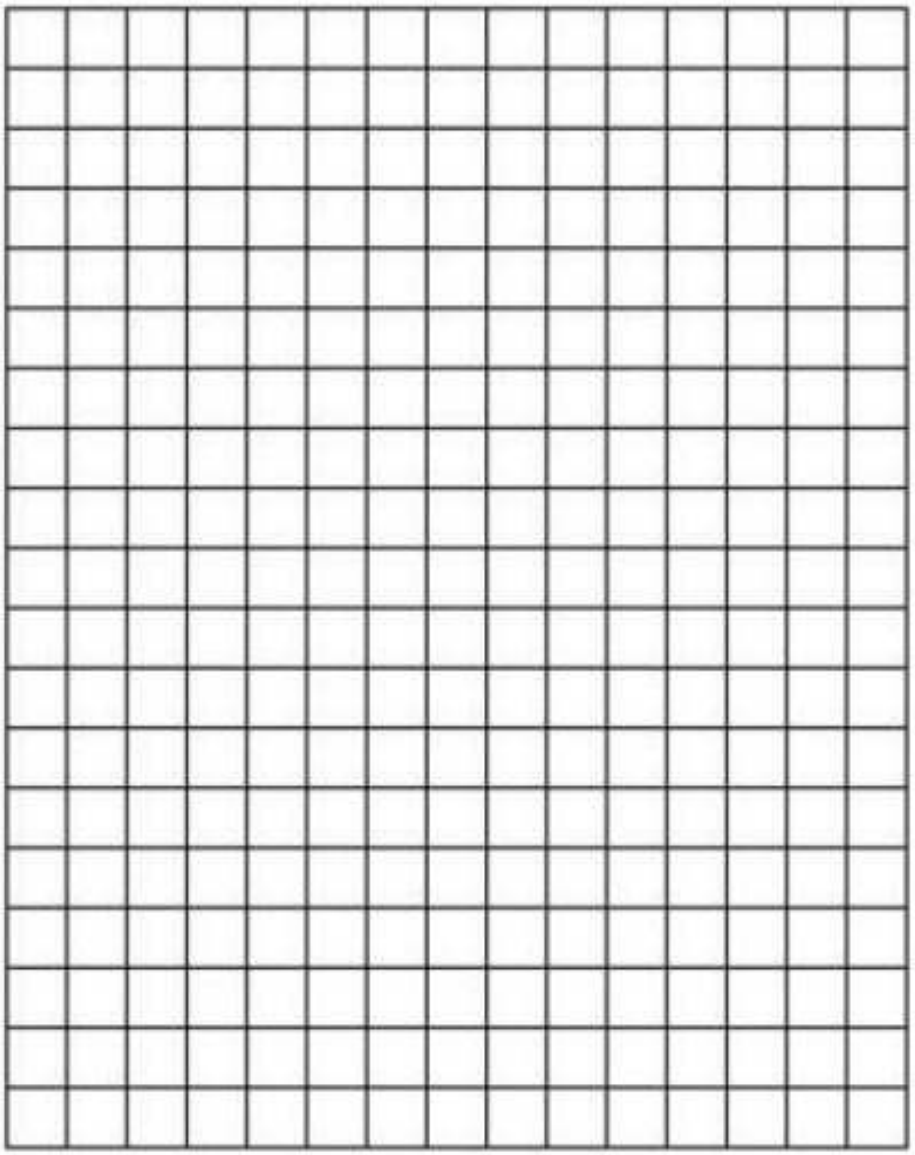
5. Draw a ***bar*** for each category ***accurately***. Each bar should be the same width, and there should be the same distance between each bar.

   - Don't forget the title!
   - Draw carefully. **Use a ruler** to draw the top lines (and side lines if not using graph paper) and to shade in.

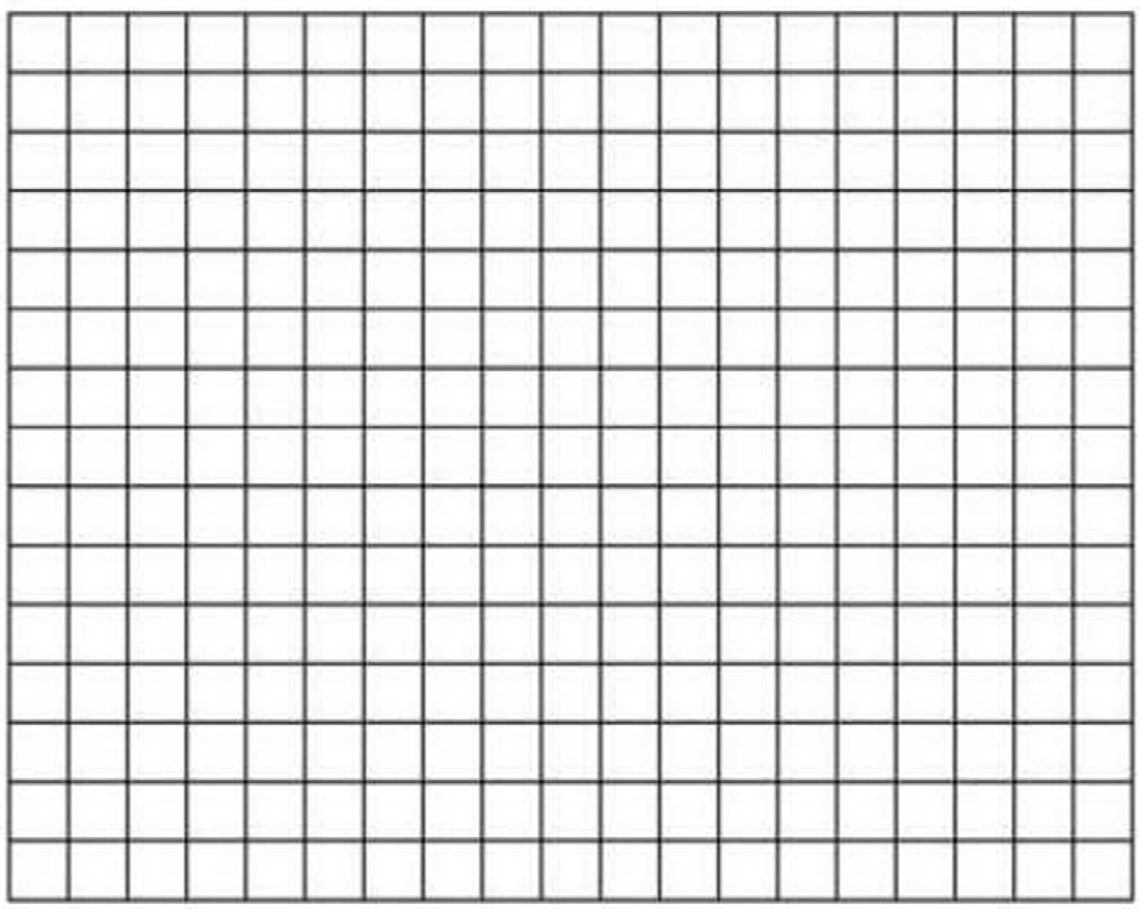
"**T.A.I.L.S graph creation** (bar, line, histogram – graph that has axes) – *acronym* to remember what these graphs must have

T	Title	Title:	Must be clear and descriptive.
A	Axes	Axes:	Drawn, neat and straight.
I	Intervals	Intervals:	Each interval increases by an equal amount, and is clearly numbered.
L	Labels	Labels:	Correctly indicate what is graphed and (in parentheses) indicate the units.
S	Scale	X/Y Scales:	Pick the intervals so that most of the graph paper is used to plot the data.

Try it! Create a ***vertical*** bar graph to represent the data on page 8.



Try it! Create a ***horizontal*** bar graph to represent the same data.

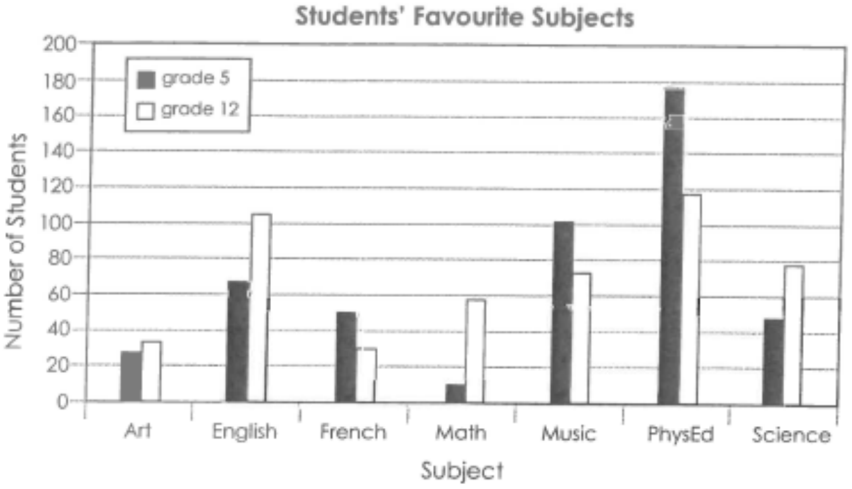


Double Bar Graphs:

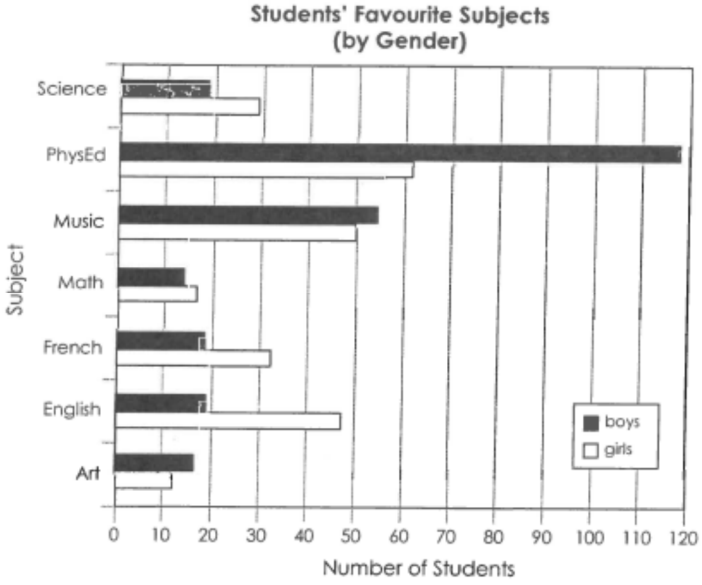
Double bar graphs compare data from ***two*** different surveys or different years, or highlight a difference that is in every category, such as boys vs girls.

NOTE:** The steps for drawing a double bar graph are the same as drawing a bar graph, however, a ***legend must be included to distinguish between the two different data sets.

Go back to the example of students' favorite subjects. The survey could be conducted on Grade 5 students and on Grade 12 students, and then compared.



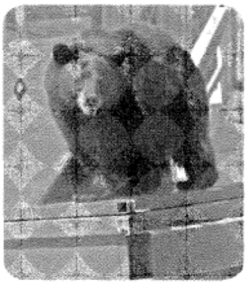
Another possibility would be to break down the data from the Grade 5 students into boys and girls.



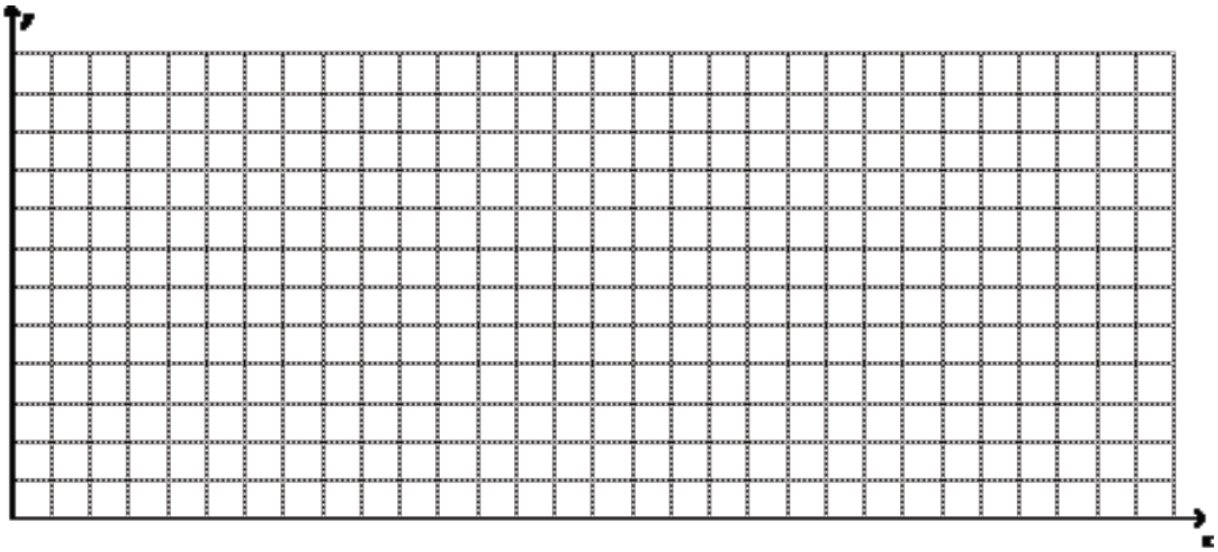
Try it! Create a ***vertical*** double bar graph to represent the data that follows.

Example

Councils in two British Columbia towns conducted a survey. They wanted to choose three ways to protect the bears and keep communities safe. The results are shown in the chart. What decision might they make from the data?



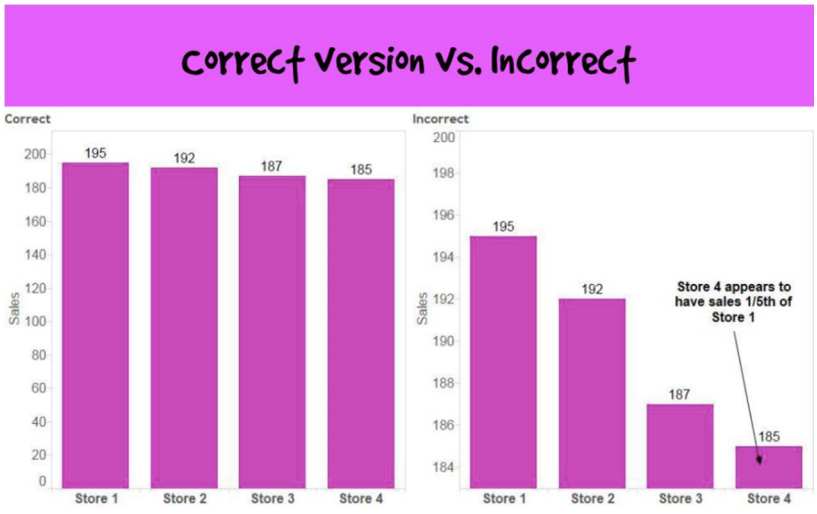
Bear Smart Program		
Suggestion	**Votes: Town 1**	**Votes: Town 2**
use safe electric fence around landfill	1020	711
remove brush in town	294	47
use bear-proof garbage cans	701	710
move problem bears to the wild	773	479
put out garbage on pickup day only	948	518
lock commercial garbage bins	60	76



The decision they might make is: _____

because

Some Advantages and Disadvantages of Bar Graphs

advantages	disadvantages
• Eye catching • Easy to understand • Easy to compare sets of data or facts (in double and triple bar graphs) quickly • The bars provide a visual display for comparing quantities in different categories or groups..	• Only for discrete data • Shows the number of items in a category (not a percentage) • You have to estimate the length of the bar so that it shows the correct value (*For example if your axis is in intervals of 1000, how do you know where exactly to draw the bar showing 832?*) • Can be difficult to read accurately • If range of data is large, some bars may be very share and hard to estimate or even hard to see. (*If your axis in intervals of 1000, how teeny is the draw a bar showing 5? Can you even see it?)* • Can be misleading if scale does not begin at zero:  • Can be misleading if sample sizes are not equal: 

Lesson #3: Histograms

In this lesson, you will:

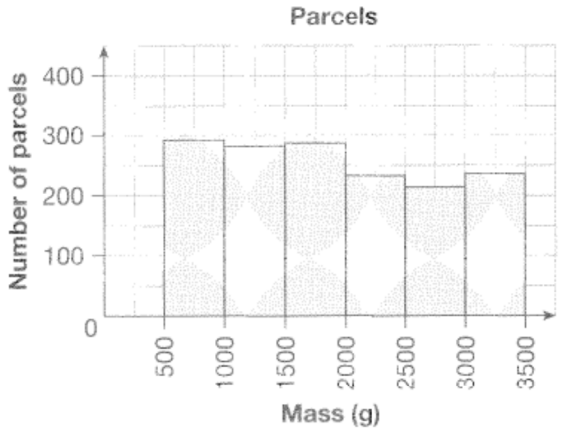
- Study histograms and the type of data they represent
- Create histograms from data
- Explore the advantages and disadvantages of using a histogram to represent data

frequency table
a table that shows the number of items in each interval

Hint
Each interval includes numbers that are greater than the lesser value and up to, and including, the greater value.

Matt works at the post office. This **frequency table** shows the masses of parcels he weighed for postage last month. What does this **histogram** tell you about the masses?

Mass (g) (over–including)	Number of parcels
500–1000	292
1000–1500	282
1500–2000	287
2000–2500	233
2500–3000	214
3000–3500	236



histogram
a graph that shows data organized into intervals of equal size; the touching bars show the frequency

1. Describe the data in this histogram.

   The horizontal axis shows masses of parcels. The width of each interval represents _____ g. The vertical axis shows _____.

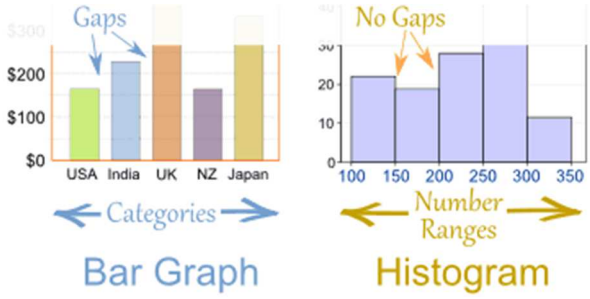
2. Circle the correct word or phrase to complete each sentence.

   For each of the first three intervals, the number of parcels is about the same / a wide range. For each of the last three intervals, the number of parcels is more / less than 250.

3. Can Matt tell the exact mass of any parcel from the histogram? _____

   What does the histogram tell Matt about mass? There are about _____ parcels in each _____ g interval. The least possible mass is just over _____ g. The greatest possible mass is _____ g.

The Parts of a Histogram:

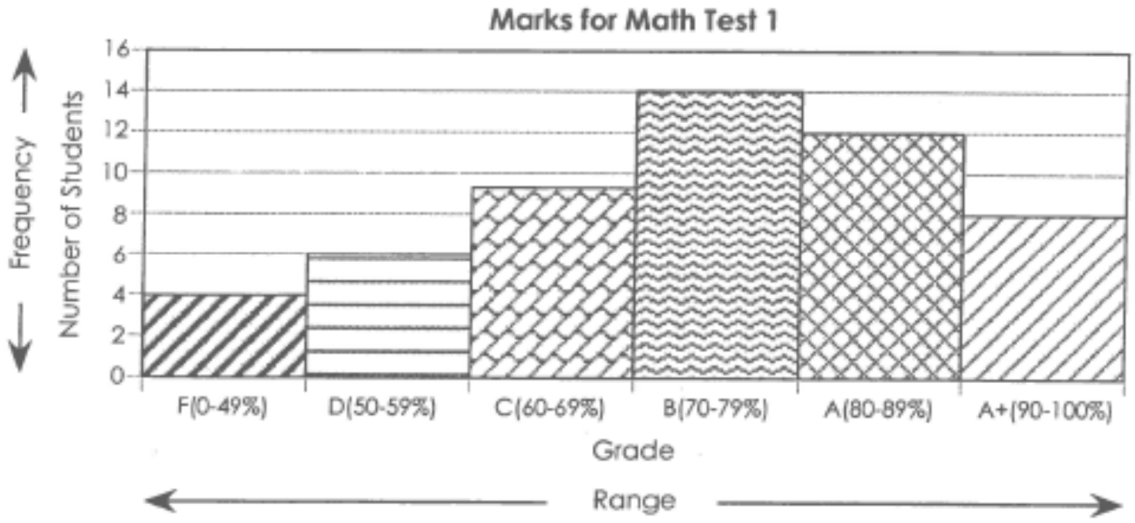


A histogram is a bar graph which shows **frequency distribution**. While histograms look a lot like bar graphs, and are created in much the same way, there are some important differences between the two.

Bar graphs display discrete data (*example one bar for each student*). **Histograms** use vertical or horizontal bars to display ***continuous data*** (data values that are connected) that is sorted into ***categories*** that represent a ***range*** of data. Continuous data *means that* ***each category*** *represents a range of values, and it is possible to have any value within the range.*

*Note: The bars **do not have any gaps** between them. The bars touch because the data is continuous. Note this on your resource sheet.

All histograms have both a ***vertical axis*** and a ***horizontal axis***.



The above graph is a vertical histogram because the bars are drawn *vertically.* The ***vertical or y-axis*** is the ***quantitative axis*** which shows the ***frequency***. The ***horizontal or x-axis*** is the ***qualitative axis*** that displays the ***range***.

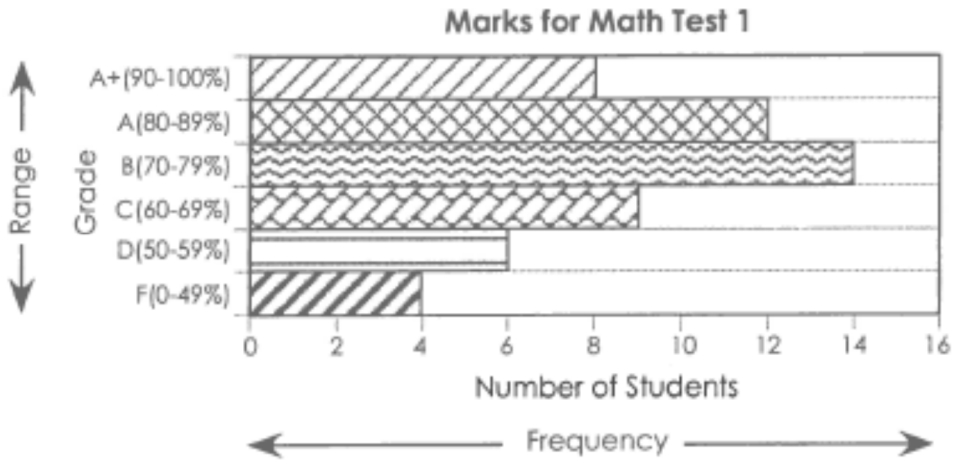
➔ The ***range*** of each category is the **difference** between the minimum and maximum values.

NOTE: Similar to a bar graph, on a horizontal histogram, the axes are switched. The ***horizontal axis*** is the ***quantitative axis***, and the ***vertical axis*** is the ***qualitative axis***.

Drawing Histograms:

Histograms must have the following:

- A title for the graph
- A title and ***labels (ranges)*** for the qualitative axis
- A title and ***uniform, appropriate, reasonable scale*** for the quantitative axis (*the frequency*)
- ***Accurately*** drawn bars, with ***NO*** spaces between them



To draw a good histogram, you need to follow 4 steps: *(remember also TAILS p. 9)*

1. **Sort the continuous data into sections** *so that all possible data is included.*
   In the above graph, the sections range from 0 to 100%. No one necessarily received 0% or 100%, but these are the minimum and maximum marks available.

   You do not need to divide the sections evenly across the range. As you can see, the category for an F is 0-49%, while the other categories have much smaller ranges. This is done to avoid having very small bars which can become hard to read and do not communicate data very well.

2. Determine the ***maximum frequency*** of the sorted data. By knowing the ***highest value*** of any category, you know how long the longest bar will be.

3. **Draw** and **label** the vertical and horizontal **axes**. *Always draw the axis describing frequency to extend further than the maximum value.*

4. Draw a ***bar*** for each category ***accurately***. Each bar should be the same width, and there should be ***NO*** spaces between bars.

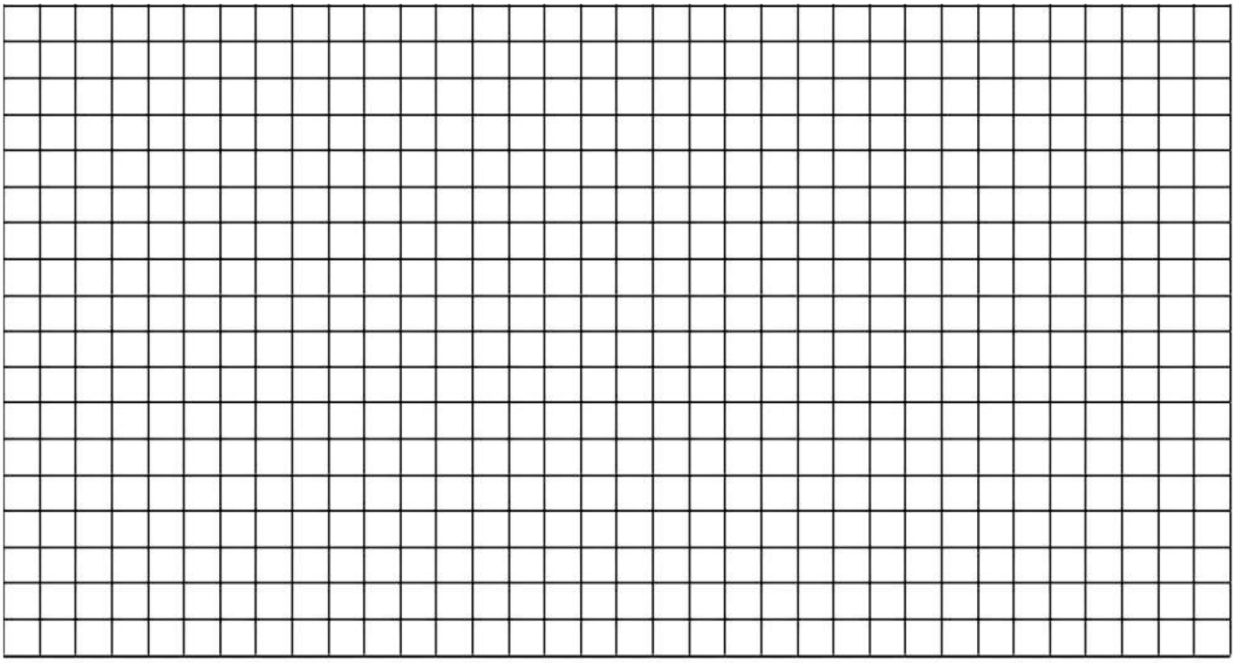
- Don't forget the title!
- Use a ruler!

Try it!

In 2007, Statistics Canada did a survey to determine the incomes of employed people in Canada. The results, after compiling the information, are shown below.

Ranges of Income	Number of People in Each Range
under $50,000	18 395 690
$50,000–$100,000	4 759 410
$100,000–$150,000	756 930
$150,000–$200,000	197 130
$200,000–$250,000	82 020
over $250,000	160 060

Create a ***HORIZONTAL*** histogram to represent this information.



Try it!

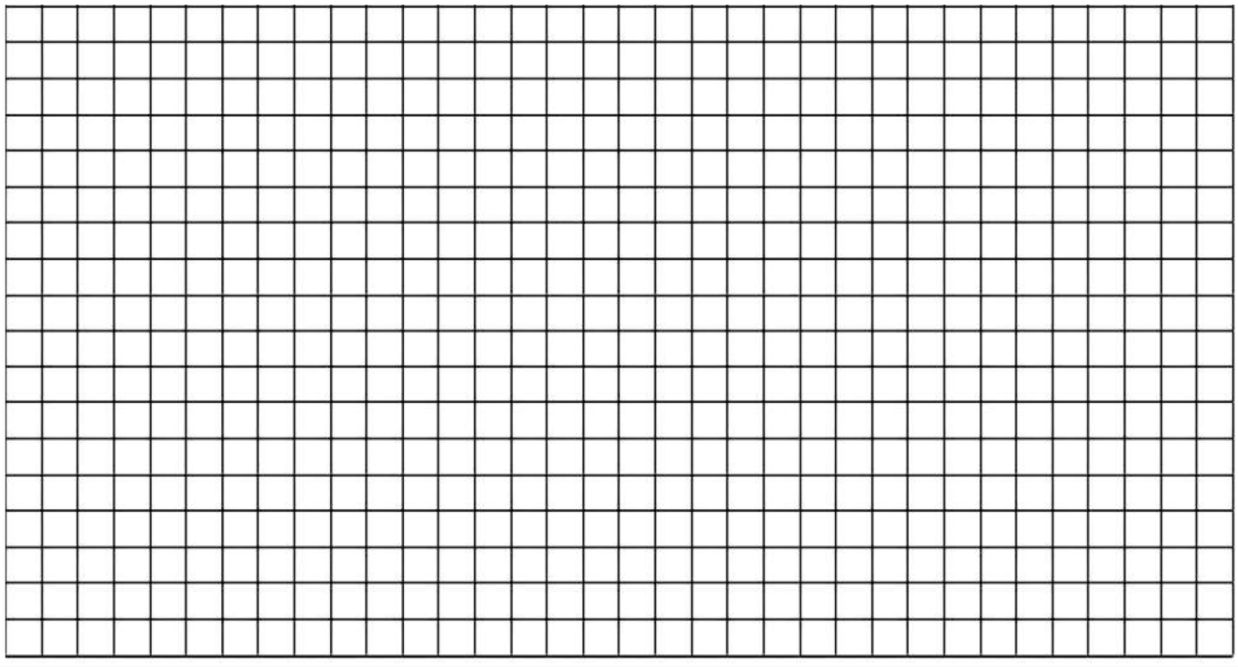
In 2001 Statistics Canada surveyed the population to find out how many people lived in Canada. The results were as follows:

Age	Number of People
0 to 4	1,696,285
5 to 14	4,029,255
15 to 19	2,053,325
20 to 24	1,955,810
25 to 44	9,096,560
45 to 54	4,419,290
55 to 64	2,868,015
65 to 74	2,142,835
75 to 84	1,329,810
85+	415,910

Create a ***vertical*** histogram to represent this data.

What conclusions can you make based on the graph? _____

_____



Creating Histograms – Construct Frequency Table

Often the histograms you will draw will have the first 3 steps completed and the frequency chart drawn. But if you are presented with raw data, you need to create a tally chart and then a frequency chart.

1. Gather the data you are interested in.
   The example data here represents the heights of students in Grade 11 in centimetres.

152	161	189	158	177	167	182	155	171	163	185	173	183
166	177	172	157	168	181	167	188	158	168	162	159	153
171	186	152	167	173	175	159	184	189	187	162	151	179
163	185	183	177	176	152	174	179	182	158	172	186	171
185	157	173	188	152	176	187	157	172	179			

2. Look at the data to determine the categories or intervals you will use to organize the data. (Sometimes the categories/intervals will be given to you but otherwise you must determine them from the data.

i. Find the range (largest value – smallest value): 189-51=38.

ii. How many groups do you want? *example*: *4 groups*

iii. 3. Divide your range by the number of groups you want.
   38 ÷ 4 = 9.5. Round up to 10

iv. 4. Pick a start value. ***152 is the smallest number so start with 150.***

v. Try it. Make a tally chart with your intervals. See if your last value works out with 4 groups with intervals of 10 cm. *If you don't like the groups, go back and change the group size or the starting value.*

Height Classes	Tally
150 - 160 cm	
160 - 170 cm	
170 - 180 cm	
180 - 190 cm	

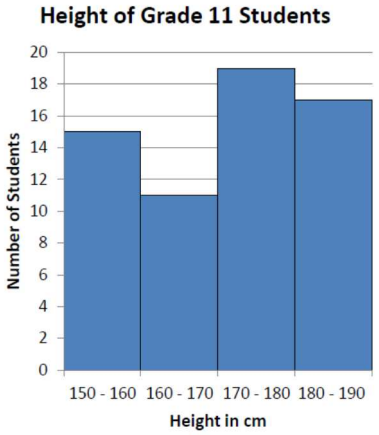
vi. Make a **tally chart** to count the number of people with heights in each category. (*Every 5th line is diagonal through the 4 lines. That way in the end you can count by 5 to find the total.) (*Count the # of data given and add up tally to make sure you didn't miss one.)

Height (cm)	Number of Students
150 – 160	15
160 – 170	11
170 – 180	19
180 – 190	17

3. Using the totals from your tally chart, construct a **frequency table** for your data. The **frequency** corresponds to the number of times each value is observed.

THE REST OF THE STEPS ARE HOW TO CREATE A HISTOGRAM. IF A FREQUENCY TABLE IS PROVIDED FOR YOU, START WITH THESE STEPS.

4. To create a histogram, draw a horizontal and a vertical axis. Decide which axis is quantitative (frequency – example *number of students*) and which axis is qualitative (categories or intervals – example *heights*). Label your axes with numbers/ categories and titles.



5. For each category/interval, draw a rectangle (without space between the rectangles). The width of the rectangle represents the interval between two groups, and the height represents the observed frequency.

Frequency Tables:

Example

This data shows the number of acres on 32 sugar beet farms near Taber. Quinn's family wants to grow sugar beets on their farm near Taber.

How can Quinn's family use this data to help them decide how many acres they should use for sugar beets?

139	61	358	169
126	350	62	159
502	290	150	74
61	462	59	122
187	72	76	66
123	66	150	191
130	145	150	231
398	836	208	420

Solution

A. Organize the data into intervals to create a frequency table. Choose the number and width of the intervals.

- Determine the range. 836 − _____ = _____
- Choose an appropriate number of intervals.
  Suppose you use 100 for the width of each interval. Divide 777 by 100 and round up to get _____ intervals.
- Start with the first interval. Choose a value that is lower than the minimum number. The minimum is _____.

B. Complete the first row in the frequency table using intervals of 100. Then complete the second row.

Make sure the chart works out. Is the highest number in your highest interval bigger than your maximum number?

Acres of sugar beets (over–including)	50–150							750–850
Frequency (number of farms)	18							1

Tally:

Calculate the tally under the frequency then write the totals for the frequency for each interval. Add up the total frequency and the number of data given to make sure they are the same.

Follow the steps on p. 15, 18, 19. Remember to divide the range by the number of intervals to find the size of each interval. Write the tally beside the frequency.

Try it!

Jill is a tour guide in Yellowknife. She takes tour groups to nearby Cameron Falls in July. She needs to let the tourists know what temperatures to expect.

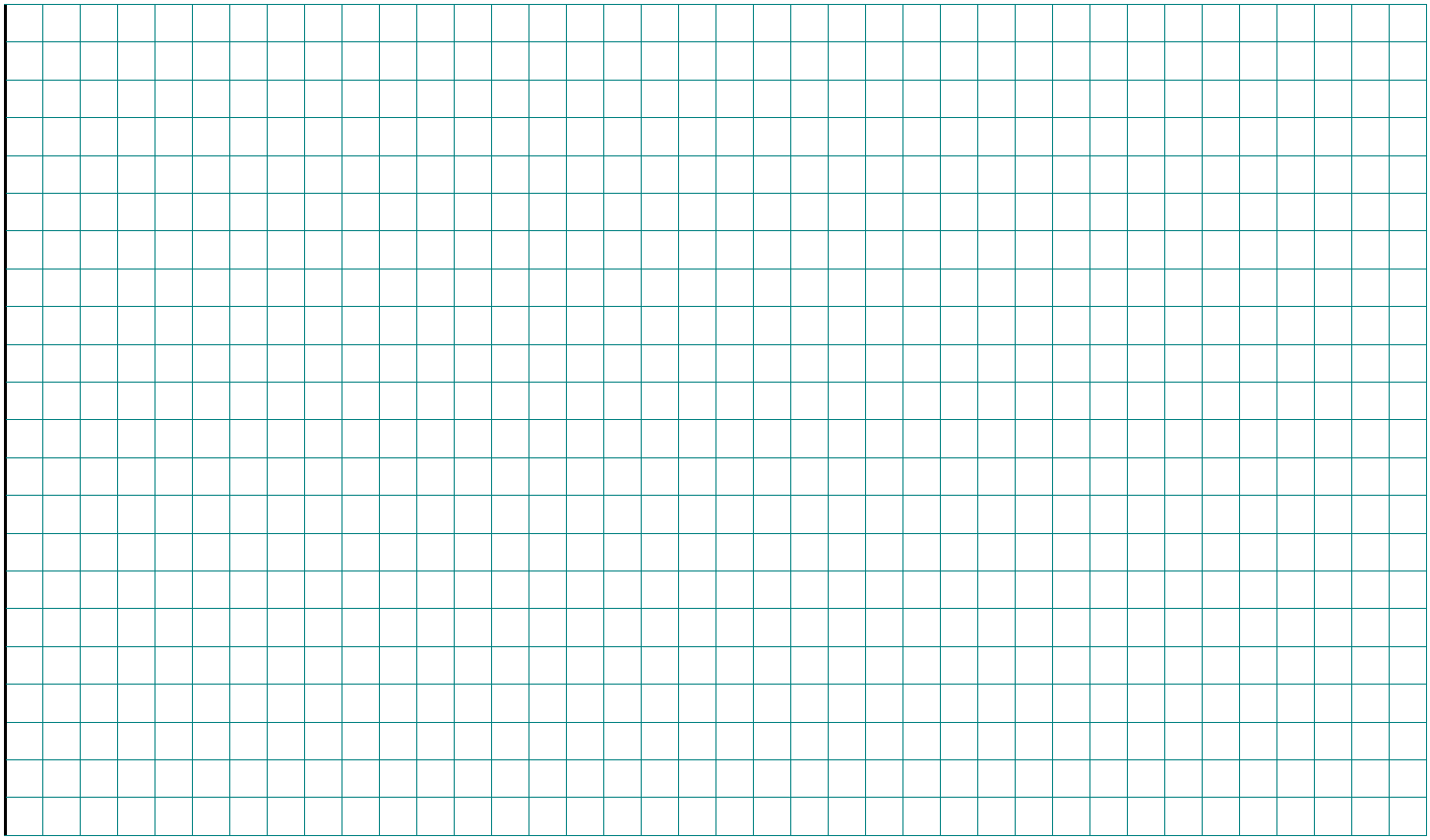
a) Use the data below to create a frequency table.

Hint
Each temperature interval must be the same size.

Temperatures from Previous Year (°C)			
13.8	13.5	15.7	16.7
13.9	16.0	13.4	18.4
15.2	18.3	16.2	19.4
13.4	20.9	17.3	19.4
12.6	23.2	19.4	21.6
12.6	21.3	21.3	20.4
16.9	20.4	21.2	20.4
19.1	17.8	20.9	

Average Daily Temperatures in Yellowknife in July	
Temperature (°C) (over–including)	Frequency (number of days)
10–13	

b) Create a histogram on grid paper.



Some Advantages and Disadvantages of Histograms

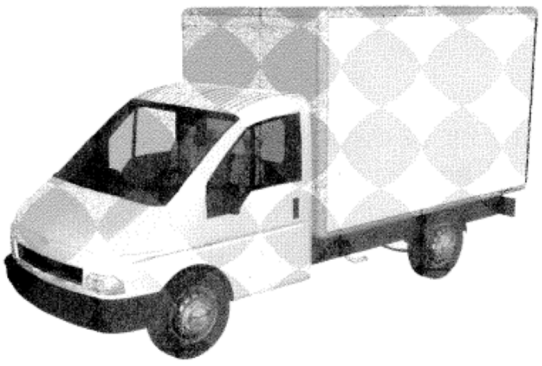
advantages	disadvantages
• Summarize data • Group data into categories so that it is easier to see patterns • Useful when describing a range of data all related to one topic (*ex. Income of Canadians)*	• Only for use with continuous data • Do not include exact data values *(ex from the graph in example on page 19, you cannot tell how many people are 25 or how many people are 44)* • Hard to compare with other data *if both graphs do not have the same categories/sections,* because you do not know how may data points from one category would be in another if you changed the range. (*ex from that same graph on p. 19, you can't divide "age 25-44" into two parts because you wouldn't know that (perhaps) only 15% of those people are older than 34*) • Can be misread. You must use correct words. (*ex. In that same graph on p. 19, some might erroneously think that the "majority" of people are between the ages of 25-44. Majority means more than 50% of the total. That age group is simply the most common. Notice too that 25-44 has an age range of almost 20 years while the others have 5 or 10 years. If you split it up, the two bars would be shorter. But we can't split it up because that's how the data was given – we* ***don't have the raw data.)***

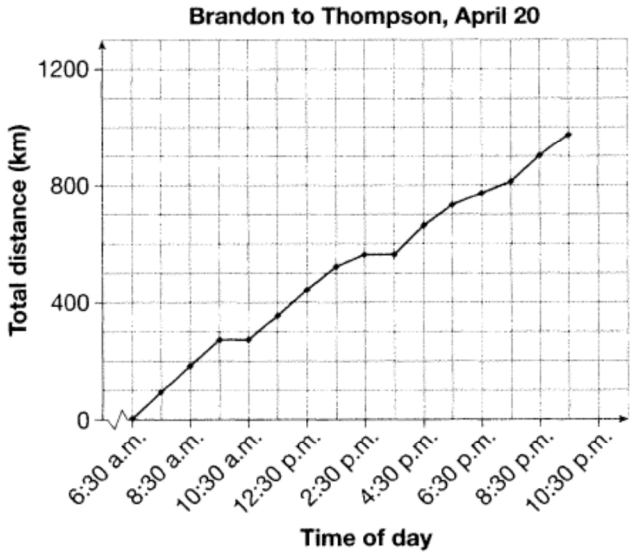
Lesson #4: Line Graphs

In this lesson, you will:

- Study line graphs and the type of data they represent
- Create line graphs from data
- Interpolate and extrapolate values from a graph
- Explore the advantages and disadvantages of using a line graph to represent data

Camden and Maria drove a delivery truck from Brandon to Thompson in a day. They created a graph from their notes about the trip. Describe their drive.





REFLECTING
Why does the line never show a decrease?

1. Describe the trend.
   As time increases, the distance travelled either _____ or _____.

2. Does the graph show they stopped at 9:30 a.m.? _____
   Explain. The line is _____.

3. How far had they driven before 9:30 a.m.? about _____ km

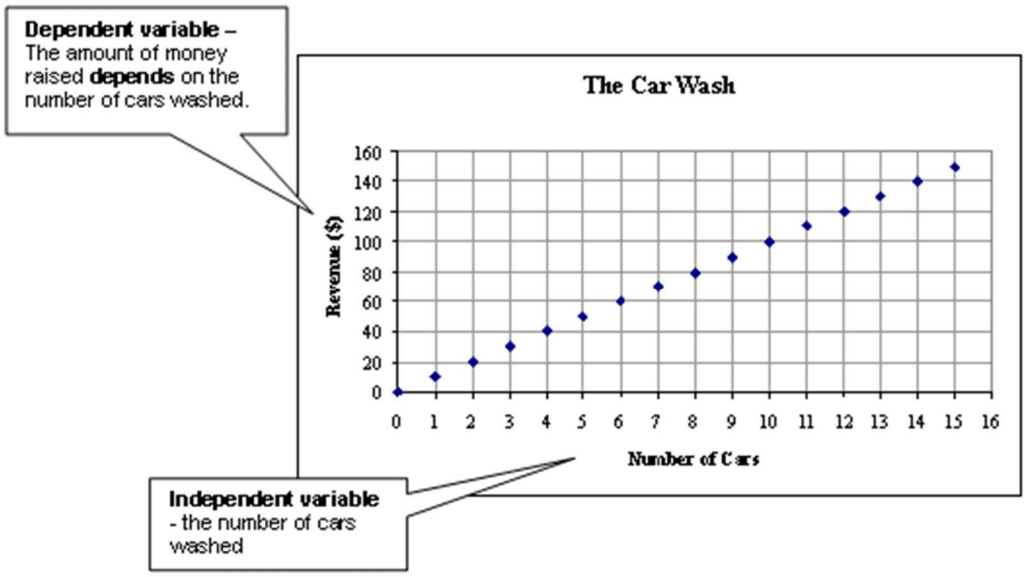
4. How long did the trip take? about _____

Axes: Independent and Dependent Variables

Line graphs, like histograms, display ***continuous data***. A line graph provides a quick visual impression of the ***relation*** between two quantities or groups of data, such as the relationship between temperature and time. One axis describes the time of day, while the other describes temperature. These two characteristics are called ***variables***.

If the line of the graph isn't straight, it is sometimes called a **broken line graph.**

- The ***independent variable*** is on the ***horizontal*** *or* ***x-axis***. The independent variable stands alone and isn't changed or affected by the other variable you are trying to measure. For example, how many hours someone studied for a test might be an independent variable.



- The ***dependent variable*** depends on other factors. For example, a person's test score could be a dependent variable because it could change depending on how much time the person spent studying. Usually when you are looking for a relationship between two things, you are trying to find out what makes the dependent variable change the way it does.

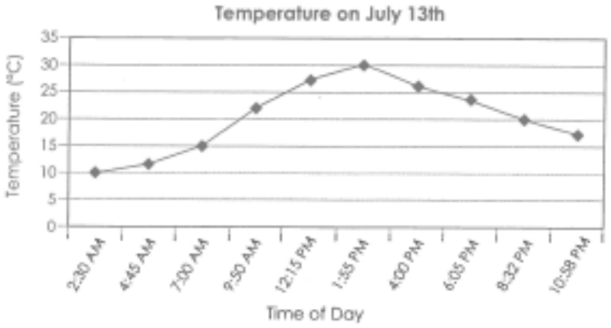
Example: Identify the dependent (D) and independent (I) variables in each statement:

a) The distance you are from home compared to the amount of time you spent driving as you go to work
b) The number of pizzas needed compared to the number of people at the party
c) The age compared to the height of a person

Drawing a Line Graph:

Line graphs must have the following:

- A title for the graph
- A title on each axes
- ***Scales*** or ***labels*** for each axes
- ***Accurately*** plotted points, ***connected*** by a straight line



To draw a good line graph, you need to follow 5 steps: (*remember also TAILS p. 9*)

1. Identify which variable is dependent (vertical y axis) and which is independent (horizontal x axis).

   A graph shows the thickness of the ice on Lake Winnipeg each month of the year.
   *→The **thickness of the ice** is the dependent variable, while the **month** is independent.*

2. Determine the range of data for **both** variables

October:	*0 cm*	*November:*	*10 cm*	*December:*	*30 cm*
January:	*75 cm*	*February:*	*75 cm*	*March:*	*55 cm*
April:	*28 cm*	*May:*	*6 cm*	*June:*	*0 cm*

   The range from October to June is 0 – 75 cm.

3. Draw and label the axes (including units). Make sure to use a ***uniform, reasonable, appropriate*** scale. Start the vertical axis at 0.

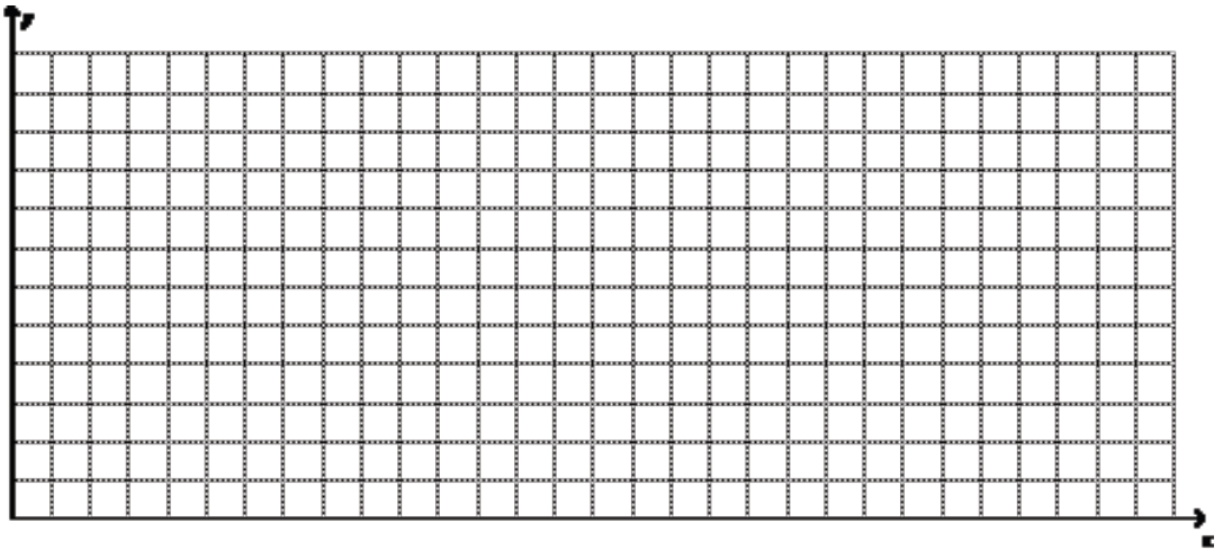
4. Plot the points on the graph. Make sure the each point is lined up with the correct values on the horizontal and vertical axes.

   The first ordered pair is: (October, 0)

5. Connect the points with a ruler, using line segments

   - Don't forget the **title!**

Try it! Create a line graph to represent the data on page 20.



Double Line Graphs:

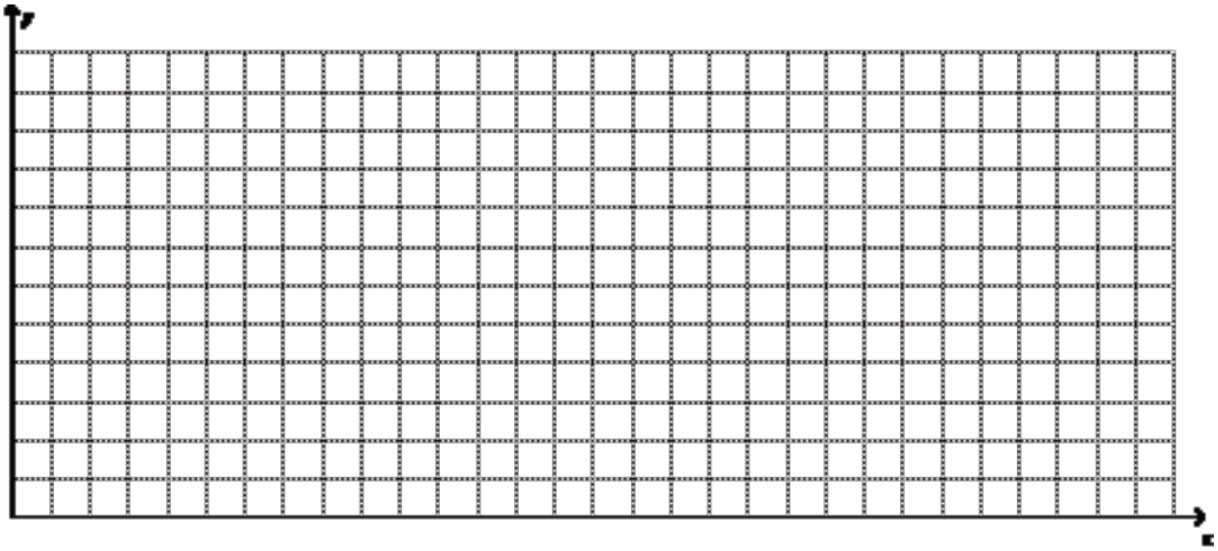
Double line graphs are similar to double bar graphs, in that they are useful when making comparisons. The steps you follow for drawing a double line graph are the same as for drawing a line graph, however you need to determine the ***ranges*** of ***both sets*** of data before you start. You also need to include a ***legend***.

Try it! Create a double line graph to represent the data below.

Tomas owns a boat shop and is tracking the sales of different brands of outboard motors. The table below shows the number of motors Tomas has ordered and the number of sales.

Type	*Brand A*	*Brand B*	*Brand C*	*Brand D*
Number bought	25	32	15	34
Number sold	21	22	14	32

Range:

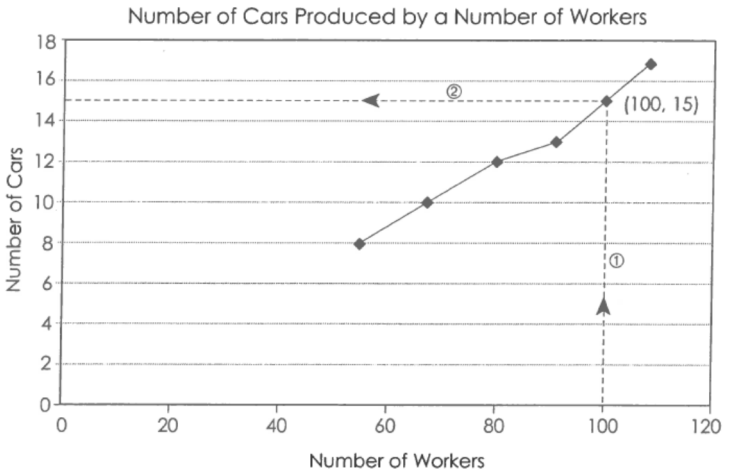


Interpolation and Extrapolation:

Unlike other graphs, line graphs provide information ***in addition*** to the data collected. You can use a line graph to ***predict*** points both ***inside*** and ***outside*** the range of data.

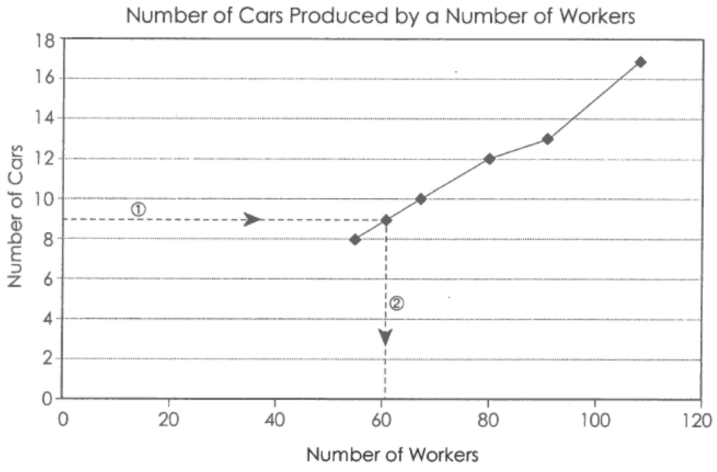
Interpolation means interpreting information from inside a set of data. It is estimating values that are ***not*** included in the data.

You could interpolate to determine the approximate number of cars produced with 100 workers. Draw a vertical line up from the 100 on the horizontal axis until it crosses the graph. Then draw a horizontal line from that point to the vertical axis.



Extrapolation is estimating information outside the range of data. You can estimate values that are ***not*** included in the data, and that lie outside of the graph by **extending the lines**.

You could extrapolate the approximate number of cars produced with 40 workers. Extend the line to the left of 55 people until is passes 40 people. Then follow the same steps you used with interpolation.



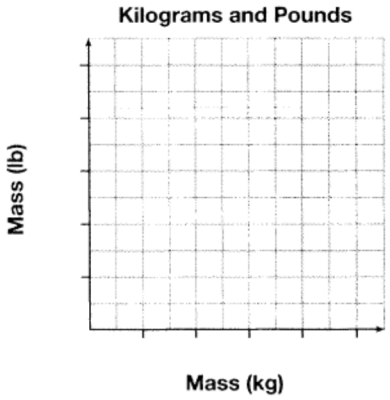
Try it!

Layla's truck can hold up to 1000 lb. She used an online converter to get these equivalent masses. How many kilograms of construction materials can she deliver in her truck?

Metric and Imperial Mass
10 kg ≐ 22.05 lb
20 kg ≐ 44.09 lb
30 kg ≐ 66.14 lb
40 kg ≐ 88.18 lb
50 kg ≐ 110.23 lb

Solution

A. Label the scale for mass in kilograms and the scale for mass in pounds. Plot the points in Layla's chart. Complete the line graph.



B. What trend does the graph show?

As the mass in kilograms increases, the mass in pounds _____. The points lie in a _____ going ____ to the right.

C. **Interpolate** to convert these masses.

- a 7 kg box of nails: about ____ lb
- a 54 lb bag of cement: about ____ kg

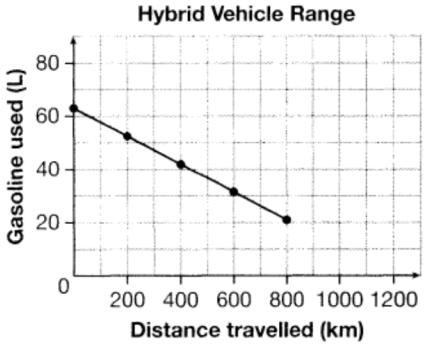
D. What is the total mass in kilograms that Layla's truck can carry?

On the graph, 100 lb is about ____ kg. So if you multiply 100 by 10 you know that 1000 lb is about ____ kg.

interpolate
estimate between known points

Example 2

Shawna created this graph about the fuel economy of her hybrid vehicle. How far can she drive on a full tank of gas?



Solution

A. How much gas did Shawna start with? ____ L of gas.

B. What trend does the graph show?

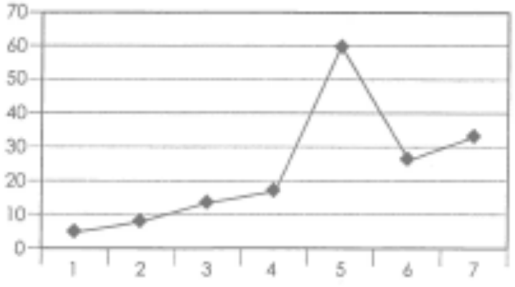
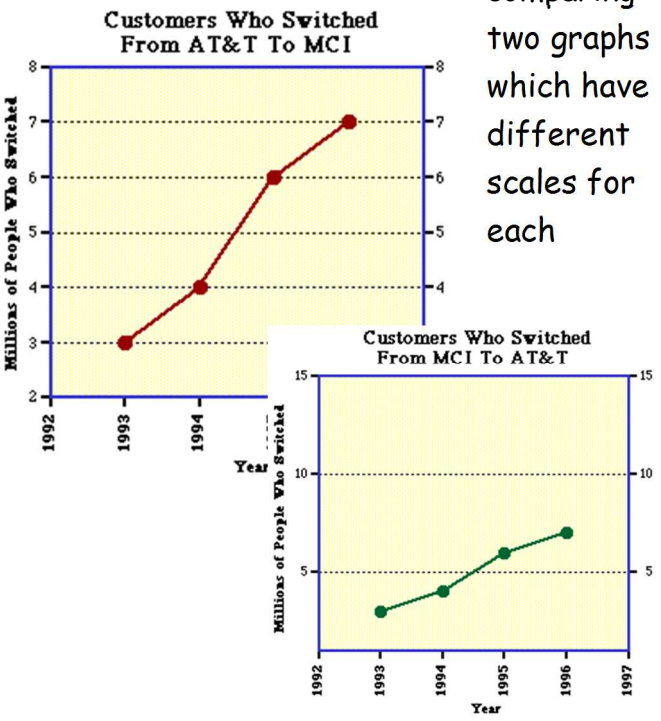
As the distance travelled increases, the volume of gas _____. The points lie in a _____ going _____ to the right.

C. **Extrapolate** by extending the graph to show when the tank is empty.

Shawna does not buy any gas. Then she can drive about _____ km before the tank is empty.

extrapolate
estimate beyond known points

Some Advantages and Disadvantages of Line Graphs

advantages	disadvantages
• Easy to quickly analyse data that changes continuously over time • Easy to compare two sets of data (double line graphs) or to see changes over time • Makes relationships and overall trends within data clear (increasing, decreasing, or fluctuating – up and down) • Shows range, minimum, maximum, and outliers clearly • Can use with discrete or continuous data • Useful for making predictions (interpolating or extrapolating) • When data is displayed in line graph, any data that does not fit the trends becomes obvious. *(Example in the line below, it's obvious that the point above 5 on horizontal axis does not fit in with the rest of the data.)* 	• If the trend of the data is not a straight line, then your estimation based on extrapolation could be less accurate. (Extrapolation can be less reliable than interpolation.) • If there are too many fluctuations in the line, it can make the trend difficult to see. • Needs small range of data • Best for fewer than 50 data values • Easy to alter or manipulate the way a line graph appears to make the data look a certain way and give a false impression (either by not using consistent scales on the axes or when comparing two graphs which have different scales for each 

Lesson #5: Circle Graphs

In this lesson, you will:

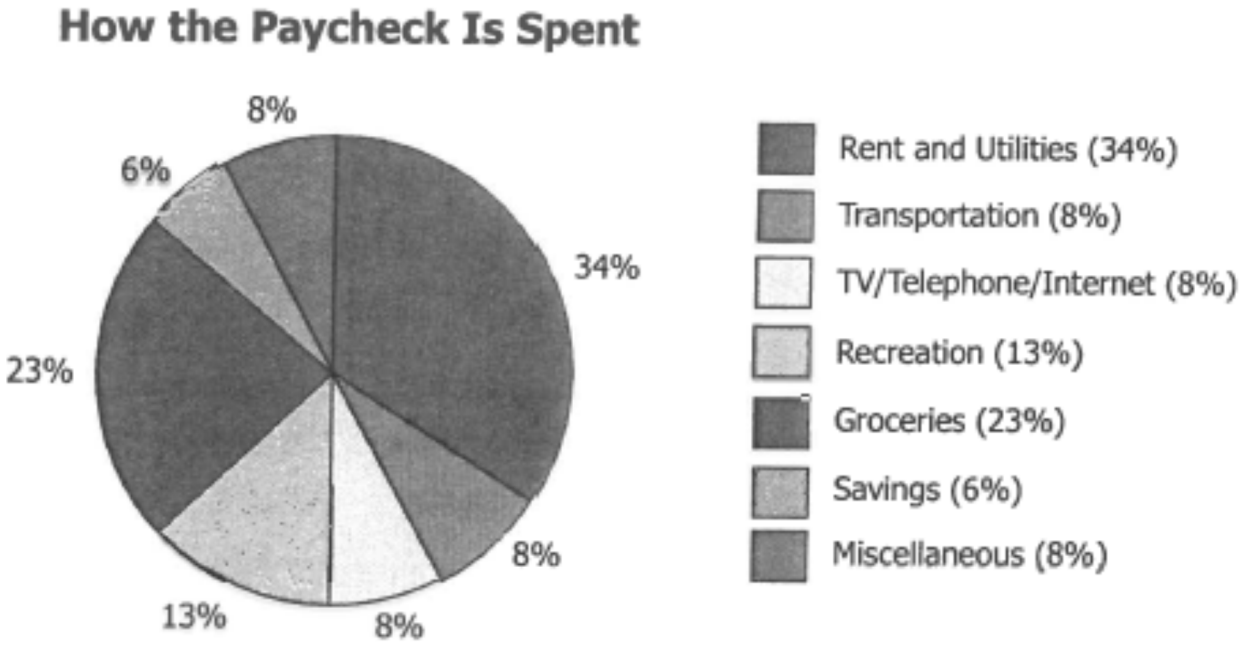
- Study circle graphs and the type of data they represent
- Create circle graphs from data
- Explore the advantages and disadvantages of using circle graphs to represent data

A ***circle graph*** represents well defined categories of ***discrete data*** as sectors of a circle (*like slices of a pizza).* All circle graphs compare ***parts of a whole***, where the *whole* represents *100% of the data.* The sections of a circle graph are labelled with a percentage, which reflects how much of the data is represented by that sector.

Drawing Circle Graphs:

Circle graphs must have the following:

- A title for the graph
- ***Accurately*** drawn ***sectors*** (correct-sized angles drawn using protractor)
- ***Percentage labels*** on each sector (beside if they don't fit)
- A ***legend*** explaining what each sector represents, and the ***actual values***
- ***Accurate*** division of the circle based on the percentage of each sector compared to the total population.



To draw a good circle graph, you need to follow 4 steps:

1. Be sure the data is ***discrete*** *(the same information cannot be placed into two or more categories)*

   Where are you in a 24 hour period, and how long are you there for? (The survey produces discrete data for the circle graph because you cannot be in two places at once.)

2. ***Rewrite*** each category of data as a ***percentage*** of the total. For each sector, take ***the actual value, divide by the total, and multiply by 100***.

   3 hours in the car, 8 hours at work, 2 hours at the gym, 11 hours at home

   Total number of hours in a day is 24:

   % in the car: *3/24 x 100 = 12.5%*
   % at work: *8/24 x 100 = 33.3%*
   % at the gym: *2/24 x 100 = 8.3%*
   % at home: *11/24 x 100 = 45.8%*

   NOTE: the sum of the percentages should be ***approximately*** 100% (may not be exact due to rounding)

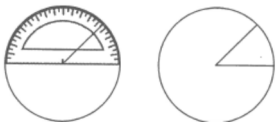
   12.5 + 33.3 + 8.3 + 45.8 = 99.9%

3. ***Convert*** the percentage of each sector into ***degrees*** (360^0). For each sector, ***convert the percentage back into a decimal (divide by 100), and multiply by 360^0***.

   Car: 12.5%/100 = 0.125 x 360^0 = 45^0
   Work: 33.3%/100 = 0.333 x 360^0 = 120^0
   Gym: 8.3%/100 = 0.083 x 360^0 = 30^0
   Home: 45.8%/100 = 0.458 x 360^0 = 165^0

4. Draw a circle with a compass, then use a ***protractor*** to draw each sector.

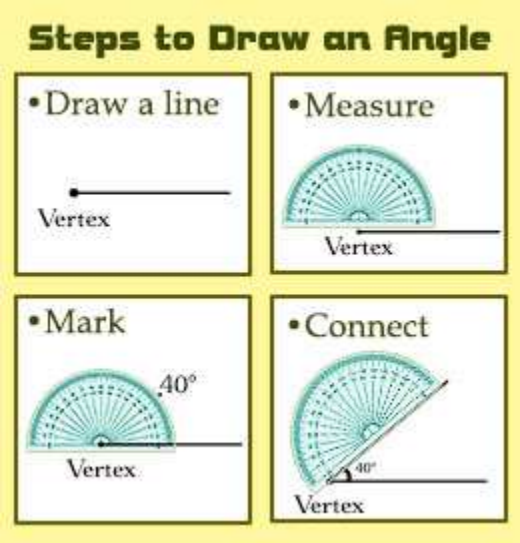
- Use a compass to accurately draw a circle
- Draw a radius from the center of the circle to the outside of the circle
- Measure the angle of the first sector from the radius using a protractor (*ex. car 45°)*

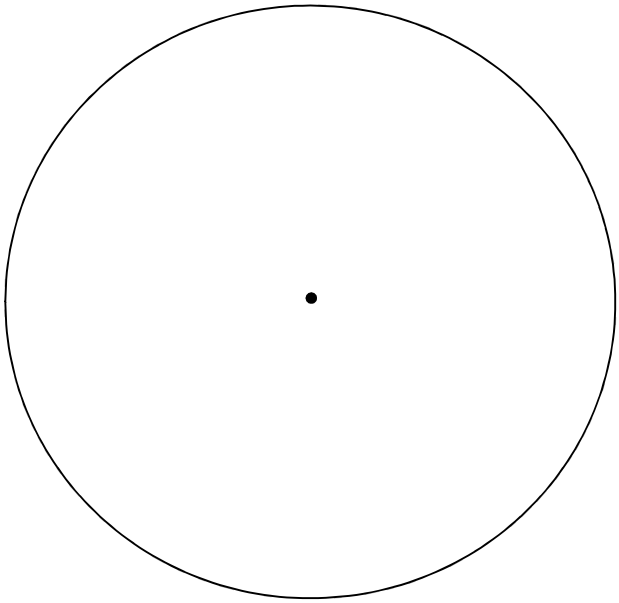


- Continue measuring the angles of the sectors from the previous sector
- Label each sector with their percent values (not the degrees)
- Place the legend beside the circle, including percents and actual values
- Give your circle graph a title

Include these 4 steps in your own words in your resource sheet.

- **Try it!** Create a ***circle graph*** to represent the data on page 32. Use a compass to draw the angles. Use the degrees in step 3 to draw the angles for the sectors.
  Hint: you may find it helpful to turn the paper. Each time you draw an angle, that line becomes the starting point for your next angle.
  Hint: measure the final angle to make sure it's accurate.



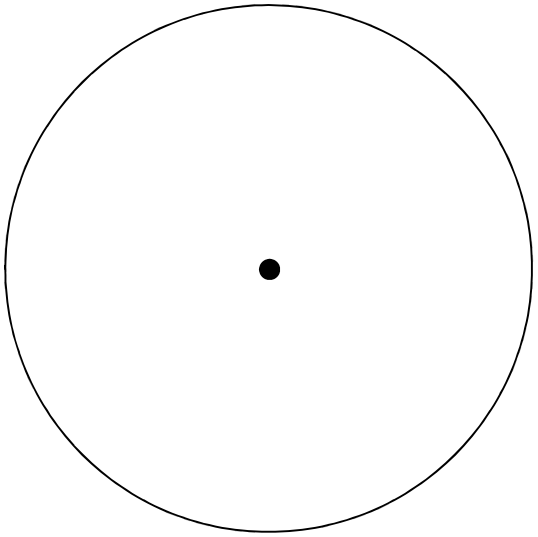


Try it! Create a ***circle graph*** to represent the following data. Liza is a fitness coach. She read the main ingredients in a new 85.0g protein bar.

a) Complete the chart.

"Chocolate Brownie" Protein Bar			
Ingredient	**Mass (g)**	**% of total mass**	**Angle measure**
protein	34.0		
total carbohydrates	33.0		
total fat	6.0		
sodium and potassium	0.5		
other	11.5		
total			

b) Draw a circle chart of the above data. Include a legend.



c) The mass of protein is **more/less** than that of carbohydrates.

d) Protein has almost _____ times more mass than total fat.

e) What other type of graph could you use for this data?

Some Advantages and Disadvantages of Circle Graphs

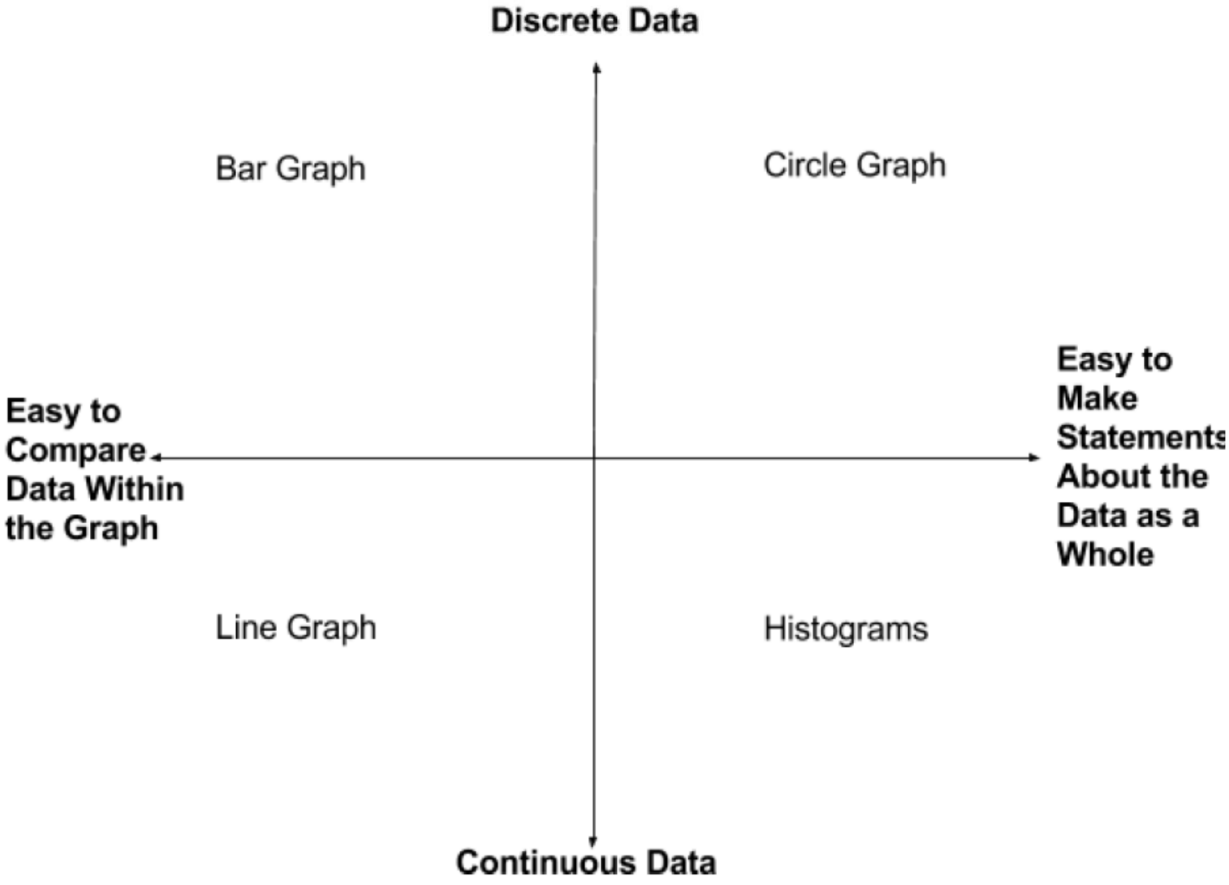
advantages	disadvantages
• Present data in a visual way that makes it easy to compare different categories of data (*see example p,31 – easy to see how paycheque spent* • Visually simple: Great way to summarize results in a way that is easily understood: largest is majority; smallest is minority • Eye catching and easy to understand • Used to compare the parts of a whole	• Not good for showing relationships between two or more sets of data • Normally show percentages and not actual data values and therefore can be easily manipulated to give false impressions (*example – if you asked 50 girls and 200 boys a question and 25 girls and 100 boys said "yes", it would look like an equal amount of people said "yes" because each category would be 50%)* • Best for only around 5 or 6 sectors, when the value of each sector is clearly different (otherwise difficult to read and to understand) • Not very effective if there are too many sectors. (*ex – can you easily tell which section is the largest and which is the* smallest?)  • If there are too many sections, you can use a category of "other" for the small sections, but then you wouldn't know what data is in the "other" section • Time consuming to construct by hand – need to do calculations and to use a compass and proctractor

Comparing Types of Graphs – Use this figure below to help you to choose which type of graph to use for your data.

The Compass Rose of Graphical Interpretations

Each segment of the figure below contains one of the graph types we have talked about. The points of this compass are labelled as follows:

- **Discrete Data:** the graph contains discrete data
- **Continuous Data:** the graph contains continuous data
- **Easy to Compare Data Within the Graph:** the design of the graph makes comparisons of information within the graph simple
- **Easy to Make Statements About the Data as a Whole:** the design of the graph allows for statements about the whole data set simple to see



How to Choose the Graph to Use

Graphs help us examine trends and make comparisons by visually displaying data. Before we can graph a given set of data from a table, we must first determine which type of graph is appropriate for summarizing that data. We have seen several types of graphs, each with its own purpose, and its own strengths and limitations . Which one we choose depends on the type of data given, and what we are asked to convey to the reader.

Sneakers Sold This Month	
Brand	**Number Sold**
Adidas	25
New Balance	18
Nike	32
Reebok	15
Other	10

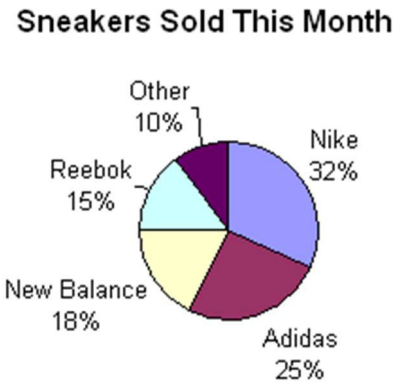
Example 1: The table shows the number of sneakers sold by brand for this month. Construct a graph which best demonstrates the sales of each brand.

Analysis:

The numerical data in this table is not changing over time. **So a line graph would not be appropriate** for summarizing the given data.

Let's draw a circle graph and a bar graph, and then compare them to see which one makes sense for this data. Before we can draw a circle graph, we need to do some calculations. We must also order the data from greatest to least so that the sectors of the circle graph are drawn from largest to smallest, in a clockwise direction.

Sneakers Sold This Month				
Brand	**Number Sold**	**Percent**	**Decimal**	**Angle Measure**
Nike	32	32	0.32	0.32 x 360° = 115.2°
Adidas	25	25	0.25	0.25 x 360° = 90°
New Balance	18	18	0.18	0.18 x 360° = 64.8°
Reebok	15	15	0.15	0.15 x 360° = 54°
Other	10	10	0.10	0.10 x 360° = 36°
Total	**100**	**100%**	**1.00 = 1**	**360°**



Circle graphs are best used to compare the parts of a whole.

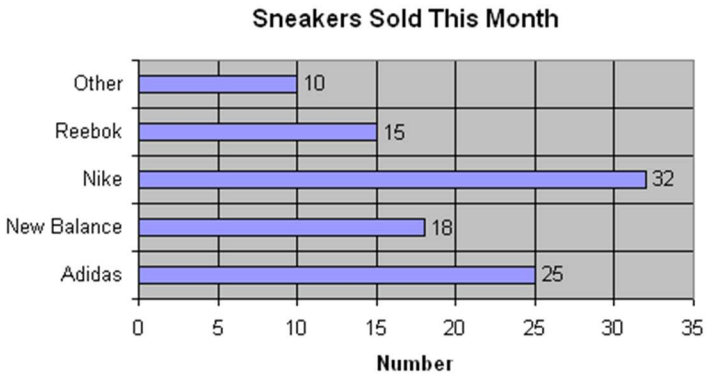
The circle graph above shows the entire amount sold. It also shows the percent of each brand's sales as part of that whole, but doesn't show the numbers of each sold.

The circle graph uses the total of all items in the table.

Each sector of the circle graph is in the same proportion to the whole circle as the number of sales for that industry is to the entire amount of sales from the table.

To construct an accurate circle graph, you must first order the data in the table from greatest to least. You also need to find each part of the whole through several elaborate calculations and then use a protractor to draw each angle.

We were asked to show the individual sales of each brands; not the percent of the whole. If we were asked to show that the Nike brand dominates the sneaker industry, then the circle graph would be a better choice for summarizing this data.



Bar graphs are used to compare facts.

The bar graph stresses the individual sales of each brand as compared to the others.

The bar graph does not use the total of all items in the table.

The bar graph simply gives a visual listing of the information in the table.

The number of sneakers sold for each item in the table matches the value of each bar in the bar graph. This makes the bar graph a more direct and accurate way of representing the data in the table.

We were asked to construct a graph which best demonstrates the sales of each brand.

Solution: Each graph above has its own strengths and limitations. However, the **bar graph is the best choice for summarizing this data based on what we were asked to convey to the reader.**

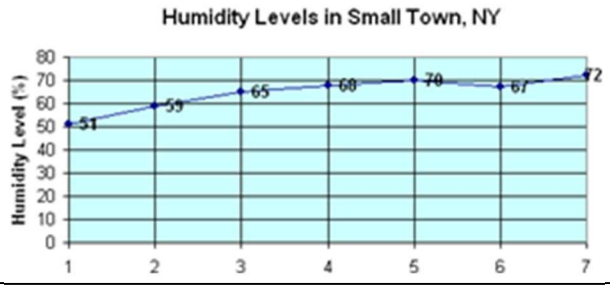
Example 2: The table below shows the humidity level, recorded in Small Town, NY for seven days. Construct a graph which best demonstrates the humidity level for each day.

Humidity levels in Small Town, NY

day	Humidity level (%)
1	51
2	59
3	65
4	68
5	70
6	67
7	72

Analysis:
The humidity level is given as a percent. At first glance, it might lead one to think that a circle graph should be used to summarize this data. However, the data in the table does not include any parts in relation to a whole. Thus, a circle graph is not the right choice. The data in this table is changing over time. So a line graph would be the appropriate choice for summarizing the given data.

Solution:



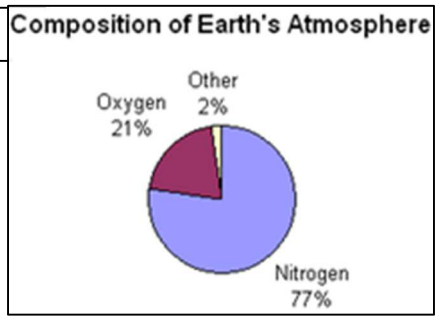
Example 3: The table shows the composition of Earth's atmosphere. Construct a graph which best represents the composition of the Earth's Atmosphere.

Composition of Earth's Atmosphere

Gas	percent
nitrogen	77
oxygen	21
other	2

Analysis:
The word "*composition*" indicates that we are looking at the parts of a whole. The Earth's Atmosphere is the **whole** (100%) and each gas is a **part** of that whole. Accordingly, a circle graph is the best choice for summarizing this data.

Solution:



Try It!

For each of the following, should you use a circle graph, bar graph, or line graph? Why?

1. The ages of 7 trumpet players in a band are 13, 12, 11, 12, 11, 10, and 12. What type of graph would be appropriate for comparing the ages of these trumpet players? _____

2. The federal hourly minimum wage was recorded each year from 1990 to 2007. What type of graph would best show the changes in minimum wage during this time period? _____

3. When asked if "antidisestablishmentarianism" has 28 letters, 50 people said "yes", 35 people said "no", and 15 people said "I don't know". What type of graph would best compare these responses to each other and with the total? _____

4. The growth of 7 different plans was recorded in centimetres. What type of graph would be best for comparing the growth of each plant? _____

5. In a city, the rainfall was recorded in inches each month for 12 months. What type of graph would best display the change in rainfall? _____

Comparing Types of Graphs:

We have seen four types of graphs, but when do you use each type??? Look at your descriptions, pros and cons charts and examples from each type of graph (*p. 7, 13, 15, 22, 24, 30, 31, 35, 37-39)* and the figure on *page 36* to help.

Type of Graph	When to use it…
Bar Graph	example:
Histogram	example:
Line Graph	example:
Circle Graph	example:

Lesson #6: Interpreting Graphs

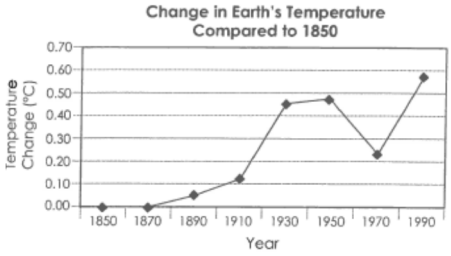
We have seen how to draw four different types of graphs. These four types – bar, histogram, line, and circle – are frequently used by media, advertisers, and others to provide statistical information in a way that can be quickly and easily understood.

However graphs are sometimes used to influence other people by modifying the way a graph is drawn. Even sometimes an "honest" graph can present misleading information.

Multiple Interpretations of One Graph

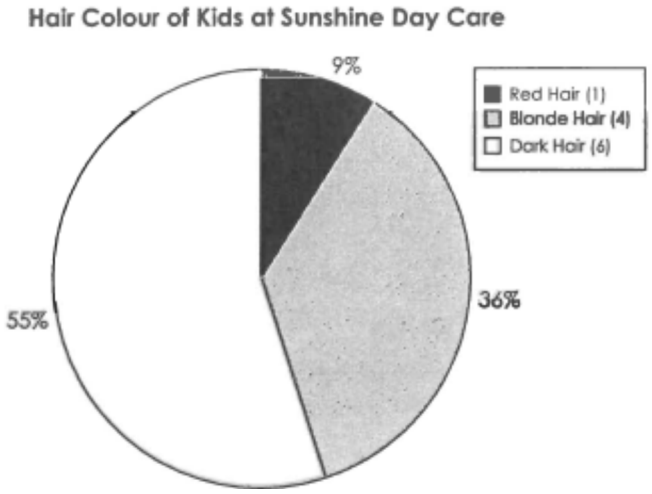
- Your interpretation of a graph may be determined by your personal beliefs or by the factual data (numbers) presented by the graph.

The following graph describes the average temperature changes on the earth from 1850 CE to 1980. Based on the information in the graph, we could draw many different conclusions about Earth's temperature. For example:



1. Whatever we did between 1950 and 1970 was effective in lowering Earth's temperature.
2. As it did between 1930 and 1950, Earth's temperature may plateau (stay approximately the same).
3. Earth's temperature is increasing rapidly.
4. We do not need to be concerned about Earth's temperature because it is not increasing by that much.

The first two statements might be personal beliefs based on whether someone is concerned or not about an increase in the Earth's temperature. The second two statements might be based on the factual data. One person might be concerned about the sharp vertical rise. Another might not be concerned about a temperature increase of 0.6°C in 100 years.



Try it! State two different ways someone could interpret the graph. Include one possible reason for each interpretation.

1. _____

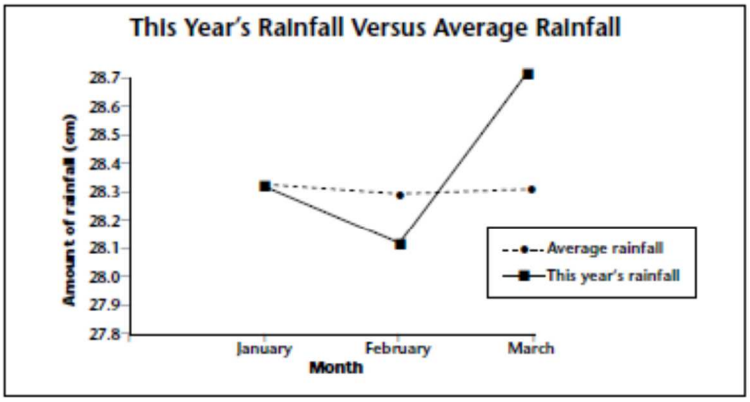
2. _____

Misleading Data:

Graphs can be used to display your data at a glance. However, graphs can distort your results if you are not careful. The picture that results may not be **objective**, or without bias or distortion. Look at the first graph.

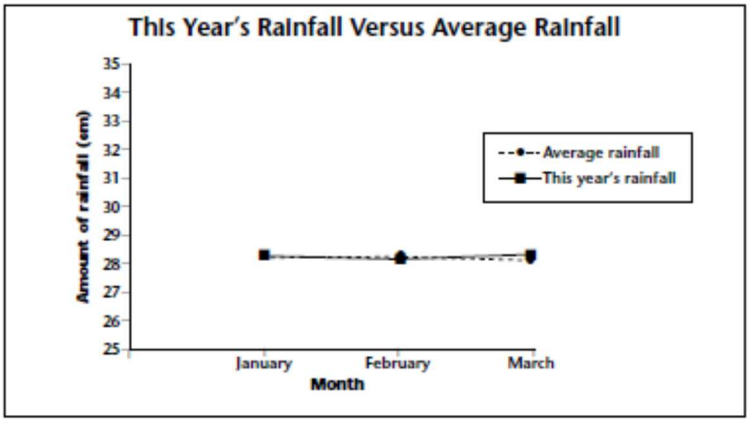
How Much Rain Really Fell?

In the graph below, it appears as though March had drastically more rainfall compared with an average month. But did that really happen?



Wait! March's rainfall was only 0.4 cm above average. On the graph, that looks like a large increase. On the ground, a 0.4 cm increase is not that much. This graph is *biased* because it exaggerates the difference between the two lines. Because the interval between 27.8 cm to 28.7 cm on the *y*-axis is so small, the difference in rainfall seems very large and noticeable.

If you increase the interval between numbers on the *y*-axis, the scale becomes larger. That makes the difference between the two lines smaller, as shown below.



1. What is the range of values on the y-axis in the second graph?

2. Which graph is a more accurate picture of the data? Explain.

A Matter of Scale

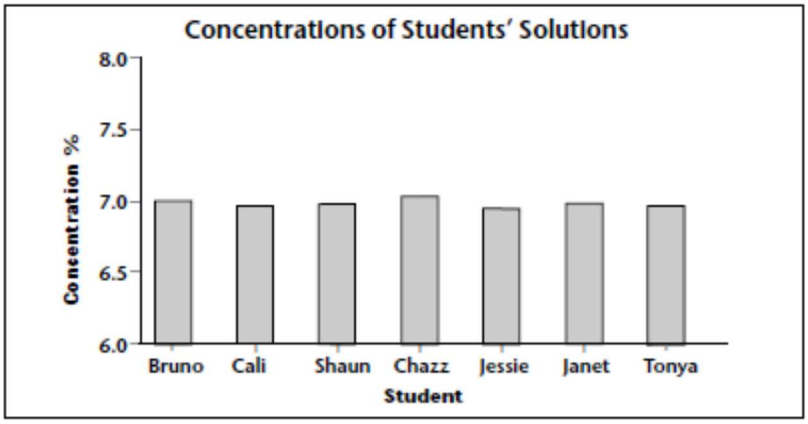
Here is another example of how the choice of the scale can alter a graph.

In an experiment, seven students tried to mix a solution of salt water so that its concentration would be exactly 7.00%. When the teacher tested the concentration of their solutions, he got the following results:

Concentrations of Students' Solutions

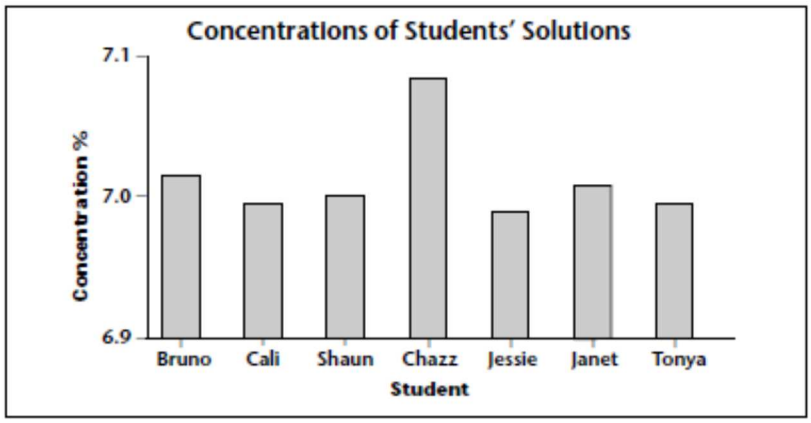
Name	Bruno	Cali	Shaun	Chazz	Jessie	Janet	Tonya
Concentration	7.02%	6.99%	7.00%	7.08%	6.97%	7.01%	6.99%

The teacher created the following graph to show the students' results:



Does this graph give you a clear picture of how the concentrations varied? Not really. The bars look so much alike that it's hard to tell the differences between them.

Suppose the teacher decreased the scale of the *y*-axis. The graph would then look like the one below. The variation in the students' results looks much greater, even though it hasn't changed. This graph makes it easier to see the small differences.



Graphs with an Attitude

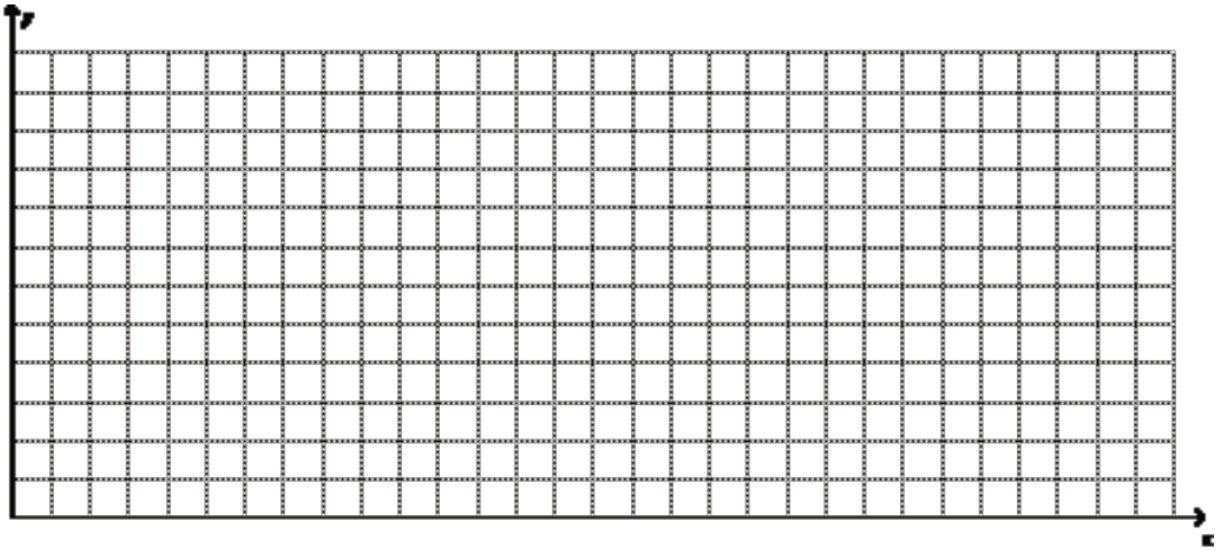
The data in the chart below were recorded by a student measuring the thickness of four rock layers.

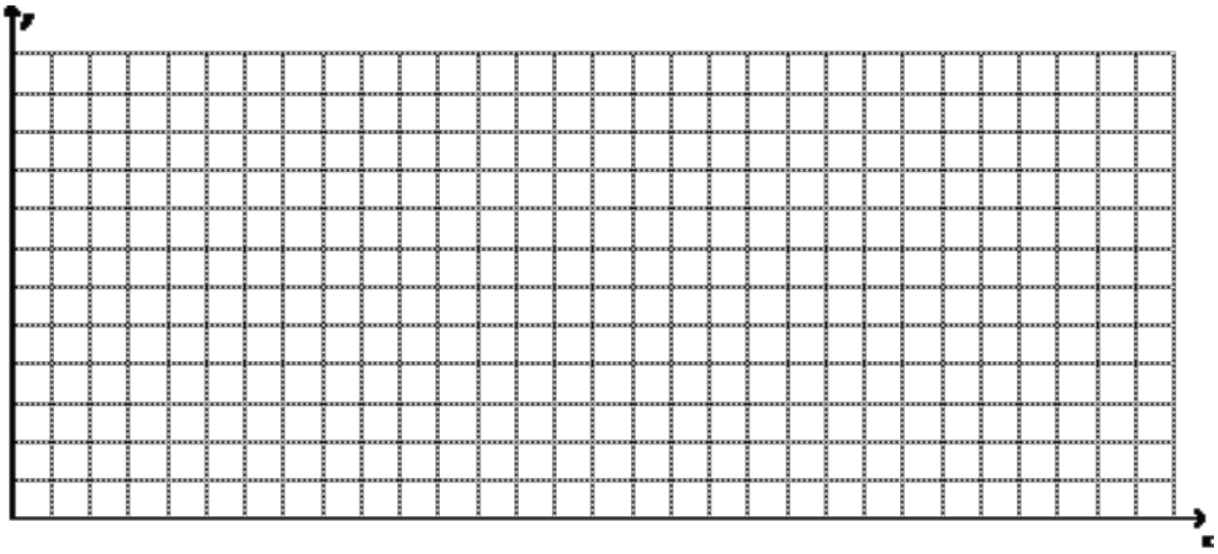
Thickness of Rock Layers

Layer	A	B	C	D
Thickness	11.2	10.8	13.5	11.1

Using the above data, create two graphs in the space below. First show how similar the measurements are. (Hint: Make the scale of the *y*-axis larger. This makes the difference between the measurements seem smaller.) In your second graph, emphasize the fact that layer C was slightly thicker than the other layers.

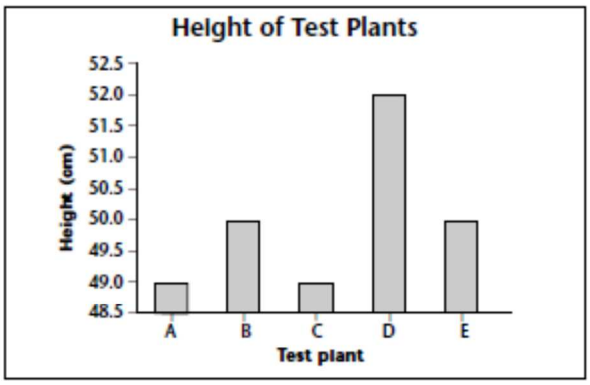
Your Graphs:





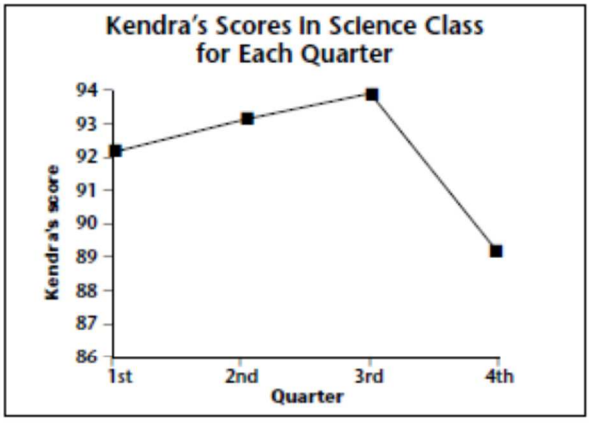
Identifying Bias on Your Own

Graph 1

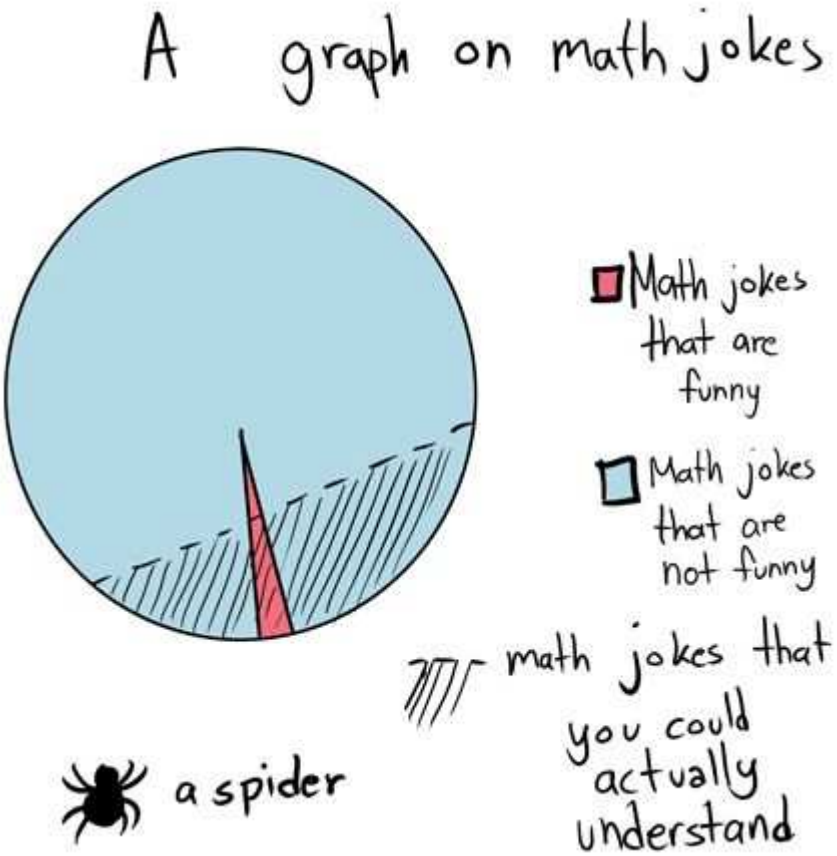


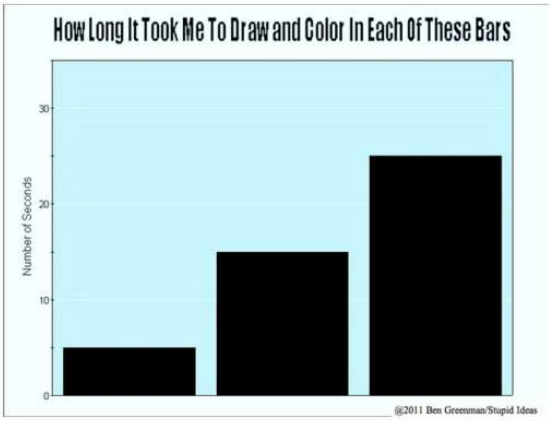
1. This graph shows that test plant D grew much taller than the other plants. How is this information misleading?

Graph 2



2. This graph shows that Kendra received a much lower grade in science class during the fourth quarter. Do you think what appears to be such a large drop in her grades should worry Kendra? Explain your reasoning.


A graph on math jokes
Math jokes that are funny
Math jokes that are not funny
math jokes that you could actually understand
a spider


How Long It Took Me To Draw and Color In Each Of These Bars
Number of Seconds
30
20
10
0
@2011 Ben Greenman/Stupid Ideas


SITTING IN STATISTICS CLASS
KEEP HEARING "INSTAGRAM" INSTEAD OF HISTOGRAM
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